ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 64. No. 14. 220 Broadway, New York, October 6, 1910.

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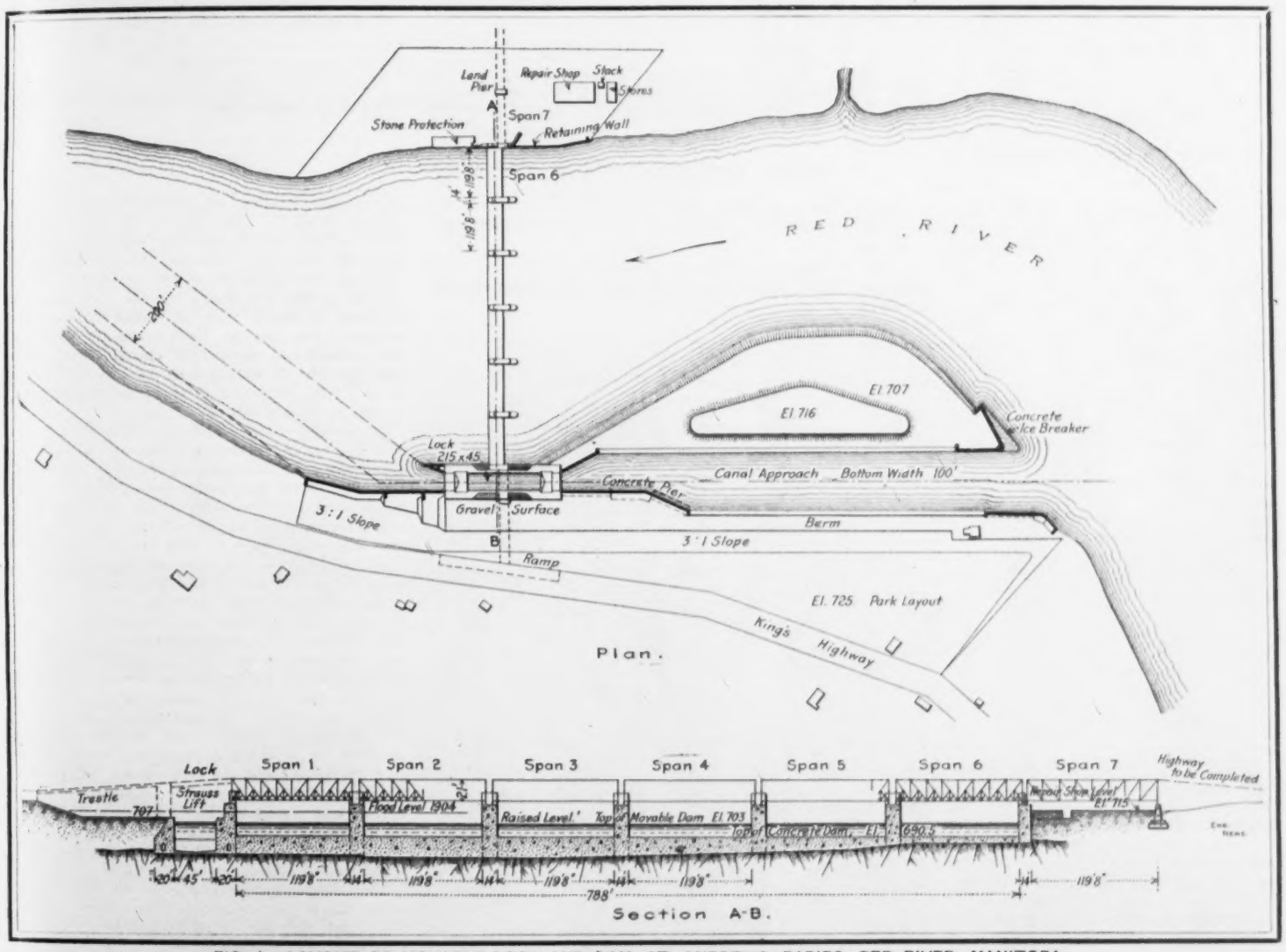


FIG. 1. LAYOUT OF MOVABLE LOCK AND DAM, ST. ANDREWS RAPIDS, RED RIVER, MANITOBA.

The Design and Construction of the St. Andrews Movable Dam and Lock on the Red River at Lockport, Manitoba.

By EDWIN A. FORWARD.*

Taking its rise near the headwaters of the Mississippi, the Red River flows northward through Minnesota and Dakota into the Province of Manitoba and loses itself in the waters of Lake Winnipeg. This lake is almost an inland sea having an area of 10,000 square miles, and furnishing a fine stretch of inland navigation extending nearly 300 miles into the north. The development of a great tract of country tributary and adjacent to this lake will, to a great extent, be in proportion to the use that is made of these waters in establishing lines of communication.

The distributing point for this section of Canada is and always will be Winnipeg, with her cluster of great transcontinental railways, reaching out to all parts of the continent. Situated as she is, at the junction of the Assiniboine with the Red River, 50 miles above the lake, the city is the meeting point of railway and waterway. For years there has been a fine fleet of steamers plying on the lake, but, owing to natural barriers in the river, they have been unable to come farther than Selkirk, with its one railway, 25 miles below the city.

Eight miles above Selkirk the St. Andrews Rapids is encountered. The river for a distance of ten miles is rocky and strewn with boulders, the stream swift and shallow with a 15-ft. fall. Only swift stern-wheeled steamers of shallow draft have been able to use this part of the river. By reason of this rapid, the city of Winnipeg, in the midst of a prairie country, has long been debarred from the use of the natural resources of a district totally different in character, a district that is yet to-day only in the hands of the prospector. The recent completion of a lock and dam at the foot of St. Andrews Rapids by the Dominion Government creates a slack-water reach extending up to the city and beyond, and navigable for vessels drawing 9 ft. of water, permitting the

*Engineer-in-Charge of Construction, St. Andrews Dam. P. O. Box 2966, Winnipeg, Man.

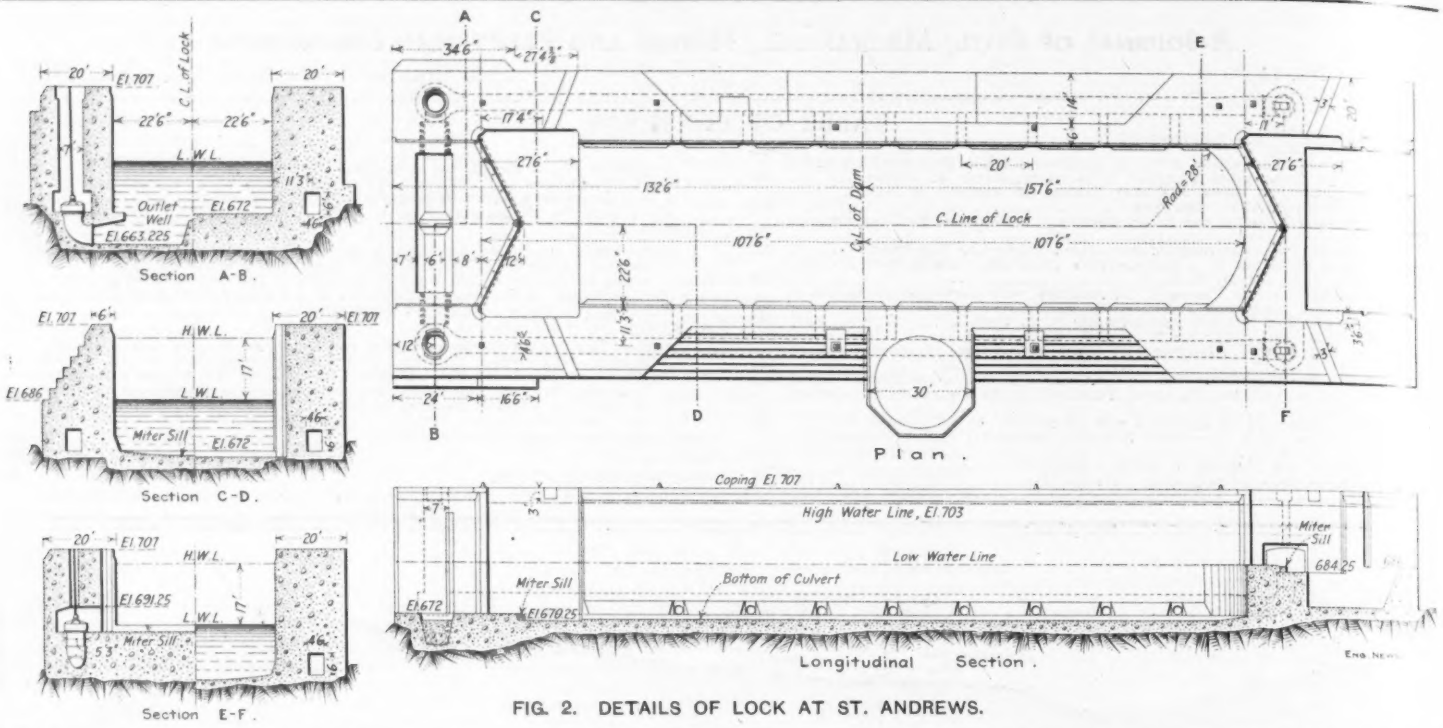


FIG. 2. DETAILS OF LOCK AT ST. ANDREWS.

lake boats to dock at the city wharves. This brings Winnipeg into touch with three great rivers; the Saskatchewan, extending for a thousand miles to the foot of the Rockies, and now under examination with a view to establishing a system of navigation; the Nelson, which ranks among the largest of American rivers, and the Winnipeg, with its enormous water power so easy of development.

The placing of a dam at the foot of the rapid presented some serious difficulties. The Red River drains a very large area of prairie country where the stream is subject to very rapid rises. The river is noted for its freshets, and once the stream overreaches its banks the flooded areas are great. Should the water again come up into the city, as happened in the early days, the damage would be most serious.

In 1861, a steamer coming down in flood time from Minnesota was able for long distances to neglect the river entirely and to steer a straight course down the valley till the wooded districts would drive them back once more to the stream bed.

The maximum stream flow is stated to be in the neighborhood of 90,000 cu. ft. per sec., though during the past four years it has not exceeded about 35,000 cu. ft. At certain times of the year the flow becomes very small. During part of the winter of 1908-09 the total flow at the site of the dam was found to be only 725 cu. ft. per sec., the measurement being fairly accurate as the whole flow was over two spans of the completed concrete dam, the latter acting as a broad-crested weir. The maximum discharge on this basis is 124 times greater than the minimum.

The river flowing almost due north, the break-up at the headwaters occurs while winter conditions still exist farther down the valley. Throughout the Province of Manitoba the freshet water breaks up the ice while it is still 3 ft. or more in thickness and, at times, ice jams have caused very high water in some localities. To place a solid dam with spillway so near to the city would be to create a constant menace to life and property. It was imperative that large openings should be left free for the passage of ice. It was in view of the above considerations that the engineers of the Department of Public Works decided to adopt some type of movable dam in conjunction with a low submerged dam to be placed at a broad section of the river.

The type of movable dam adopted is a Camere curtain dam which is designed to retain the water at an elevation 12½ ft. above the submerged dam. This type has not been used elsewhere in America but has been employed with success by the French Government on the River Seine, France.

Lock.

The lock (Fig. 1) is placed in the west river bank at the end of the dam. It is built entirely

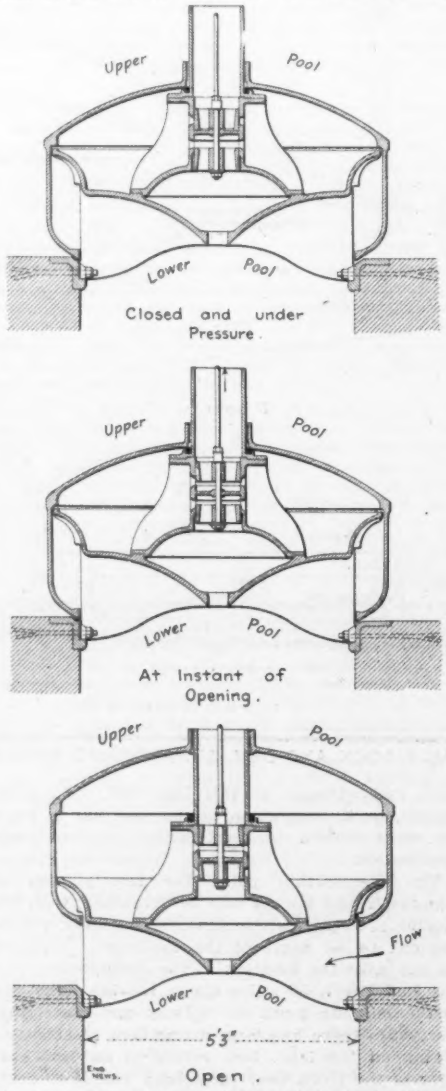


Fig. 3. Details of Cluett Automatic Valve for Opening and Closing St. Andrews Lock.

of concrete, resting on limestone rock of good quality (Fig. 2). The lift is 17 ft. at normal water or 22 ft. at the extreme low. Since, originally, the total fall from the city to the site of the dam was normally 16 ft. the water is now higher at the city docks by one foot plus the gradient of more than 20 miles of improved channel. On May 14, 1910, when the dam had been closed two weeks, the actual difference in level between Winnipeg and the lock was found to be 1.7 ft. The flow at the time was probably 15,000 cu. ft. per sec.

At normal water there is a depth of 14 ft. over the lower sill and 9 ft. at low water. The lower entrance is excavated one foot lower than the sill. With the raised level there is 17 ft. depth over the upper sill, so that when the movable dam is taken up for winter, the submerged dam will still give 6 ft. over the sill, permitting boats of shallow draft to continue the use of the lock as long as the season permits.

The lock, containing 17,000 cu. yds. of concrete, was built complete between June 22 and Oct. 15, 1907, a most creditable performance. Great care was exercised in adhering rigidly to the lines and grades given. The result is that in this respect the finished work excels the same class of work in cut stone. The specification called for a 1:2½:5 mixture with a 1-ft. facing of granite concrete on all exposed surfaces. No form was used for separating the two classes, which were placed at the same time. Gravel of excellent quality was found in the vicinity and was used without screening for the mass concrete. Expansion joints were placed in the lock walls about 30 ft. apart.

The hollow quoins are of concrete, the surface being dressed by a stonecutter after the material had been permitted to harden for a year.

GATES.—The gates are of a miter type, built of British Columbia fir, and without valves in the bottom of the leaf. A complete set of spare gates was constructed in the same contract as those installed in the lock. The gate miters against an 18 × 18-in. oak sill, set, for its protection, 3 ins. below the concrete of the miter-sill platform. The pivot block at the heel sets free in the quoin to allow it to slide out without injury should the gate be collided with or lifted up. The water rose during the ice jam of six years ago nearly 7 ft. above the present lock coping. Ballast bars will be provided against such an emergency.

The anchorage of the gate at the coping consists of two steel anchors set in the concrete and connected with link and gib and key to a hood and collar on the heel post of the gate. For

opening and closing, a steel rack arm runs underneath the coping and will be operated by an electric motor.

VALVES.—The filling and emptying of the lock is accomplished through 6 × 4.5-ft. culverts in the side walls, and the water enters and leaves the chamber through eight ports of 30-in. diameter in each side.

The regulating valves (Fig. 3) are cylindrical in design and automatic in action, the invention of Mr. S. L. Cluett. The valve is made self-operating by utilizing the difference of pressure due to the difference of head between the upper and the lower pools. This is effected by means of a small pilot valve within the valve which allows the above pressure head to act within the casing, or not, as the valve is closed or open.

When the valve is under head and the pilot valve is raised, the pressure-head becomes the same on both sides of the roof of the valve, which part is then in a balanced condition. The inside of the lower part of the valve which is turned in is not then under any pressure-head, while the outside has that due to the difference of the two pools, the vertical component of which causes the valve to rise.

The pilot is operated from the coping and requires about an inch play up or down. This valve and its case are made of gun metal, and the body of the valve of Summerlee pig showing 28,000 lbs. per sq. in. in tension. Should the pilot be out of order, the valve may be operated by an auxiliary from the coping.

The valve casing is counterweighted over chain sheaves at the coping, the casing being about 300 lbs. in excess of the counterweights, thus permitting the valve to seat itself when the two pools are equal. The weight of valve is about 5,000 lbs. and under 12-ft. head opens in about twelve seconds, the uplift pressure under that head, with

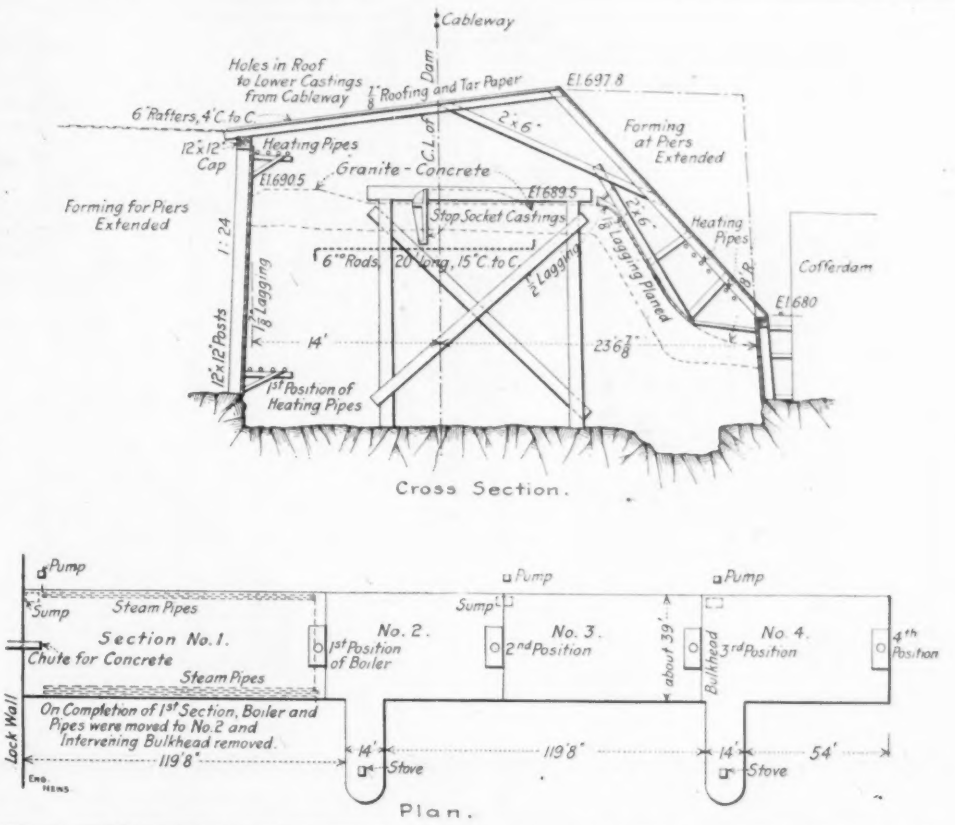
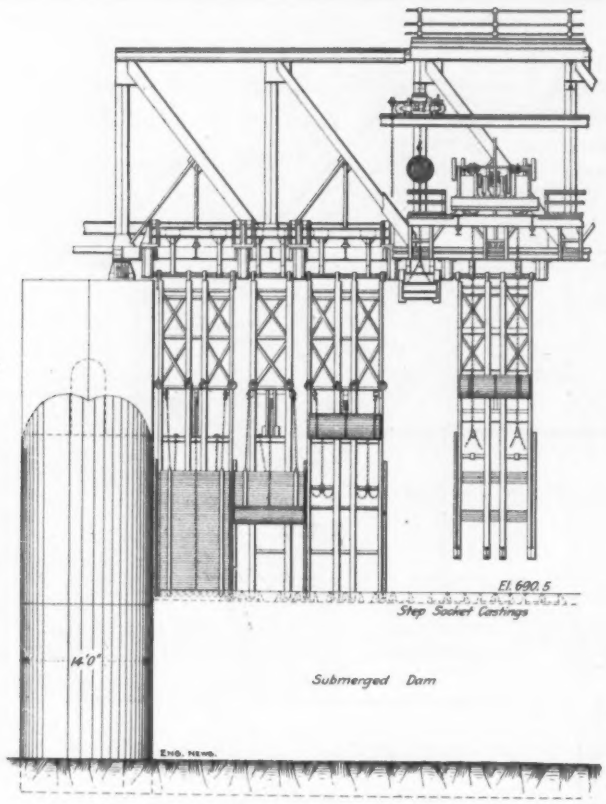
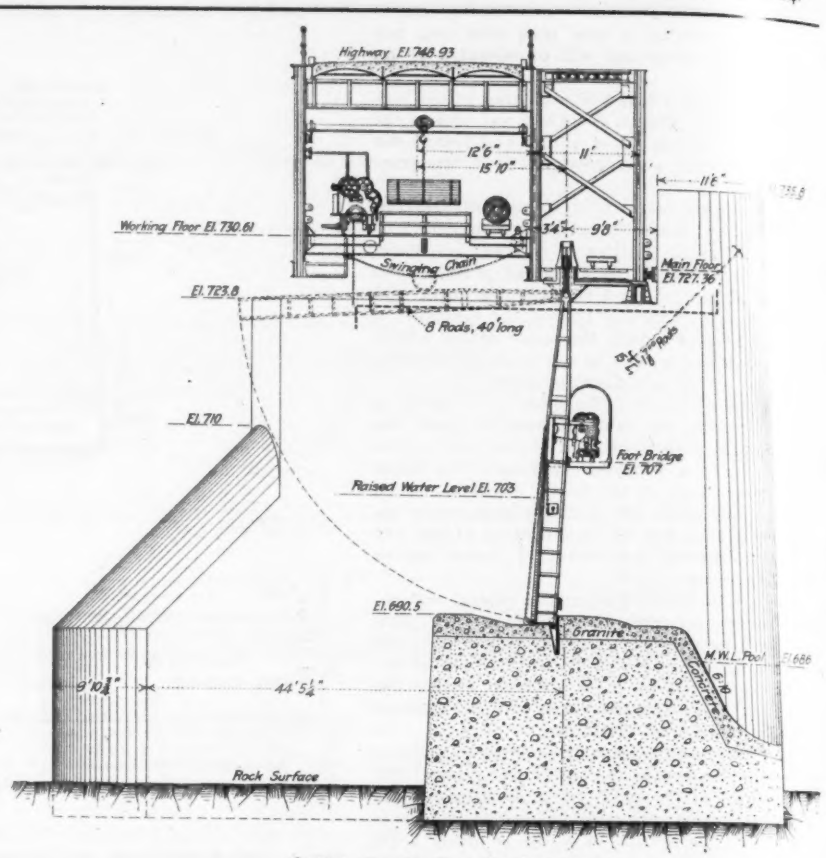


FIG. 4. CROSS-SECTION OF SUBMERGED DAM, SHOWING HOUSING, FRAMING, HEATING AND METHOD OF DEPOSITING CONCRETE DURING WINTER WORK.

FIG. 5. VIEW OF DAM DURING CONSTRUCTION, SHOWING PROTECTION FROM THE WEATHER.



Elevation Showing Frames and Curtains in Various Positions.



Section through Dam in Operation.

FIG. 6. ELEVATION AND SECTION THROUGH SUBMERGED AND MOVABLE DAM.

all weights taken into account, being 1,582 lbs. Discharge efficiency of an 18-in. working model was approximately 61%. The valve for this lock was designed by S. J. Chapleau and built by the Victoria Foundry Co., of Ottawa.

By means of a port in the lower part of the deflection floor the rate of closing may be regulated to any desired speed when under head, preventing injury to the valve. The operation is found to be most satisfactory, the lock filling in about six minutes and so quietly that a boat has no need of lines except as a precaution.

Stationary Dam.

The stationary dam consists of six clear spans of 119 ft. 8 ins. each between piers, and two abutments, the west abutment standing on the outer lock wall. The dam, like the lock, rests on bed rock its entire length. The surface rock, being shaly, was excavated to a depth of about 3 ft., removing all shaken rock or broken beds until the foundation was secure against the water forcing its way under pressure underneath the dam. An additional trench was made near the down-stream side to act as a toe.

The unwatering was done in three sections by means of cofferdams, working first from each side of the stream and finally closing out the central section. During the building of the latter section the water was carried over the two completed spans next the lock.

Owing to the extremely small flow during the winter months, it was decided to do the greater part of the river work at that season. After the completion of the lock in October, 1907, the cofferdam was made for spans 1, 2, and part of span 3. This section (about 8,500 cu. yds.) was laid during January, February and March, 1908. The average temperature for the month of January was about — 20° F.; several times — 40° and once colder than — 50° F. The severe weather did not interfere with or retard the work to any extent, only in river-bed excavation in the open, and in the teaming of gravel from the pit.

The mixing plant was previously assembled and the whole enclosed in a frame housing, covered with tar paper. A system of heating pipes leading from the power-house was installed to all mixing bins, platforms, runways, etc., where it was necessary for men to work or material to be handled; surplus and exhaust steam was utilized for this purpose. In this way the mixing water was heated. Another system was extended into the 180-cu. yd. gravel bin, the gravel being dumped from sleighs running over the bin and drawn out into cars at the bottom, thence by means of a drum off the main shaft hauled up to the mixing bins. Sand was heated in a compartment of the same bin, but stone, which was not used to any great extent, was allowed to go in without heating. It was remarked, however, that a stone and sand mixture would go into the wall at about 58° F., and drop back in a short time to about 50°, then gradually rise. When using a gravel mixture no such reaction was observed.

The portion of the dam to be built in winter was, as soon as excavated for, enclosed, section by section, in a frame building covered with tar paper. The side walls served to act as forms, the only other forming necessary being for part of the apron of the dam. (See Figs. 4-5.)

A heating boiler was set in a check left in the end of the section, the check acting as a bond between sections, and steam pipes were laid along both walls of the enclosure. These pipes were raised from time to time as the construction advanced. In addition a stove was placed in the head of each pier.

Before laying any concrete the enclosure was thoroughly warmed up and the surface of the rock cleaned and warmed by means of a jet of

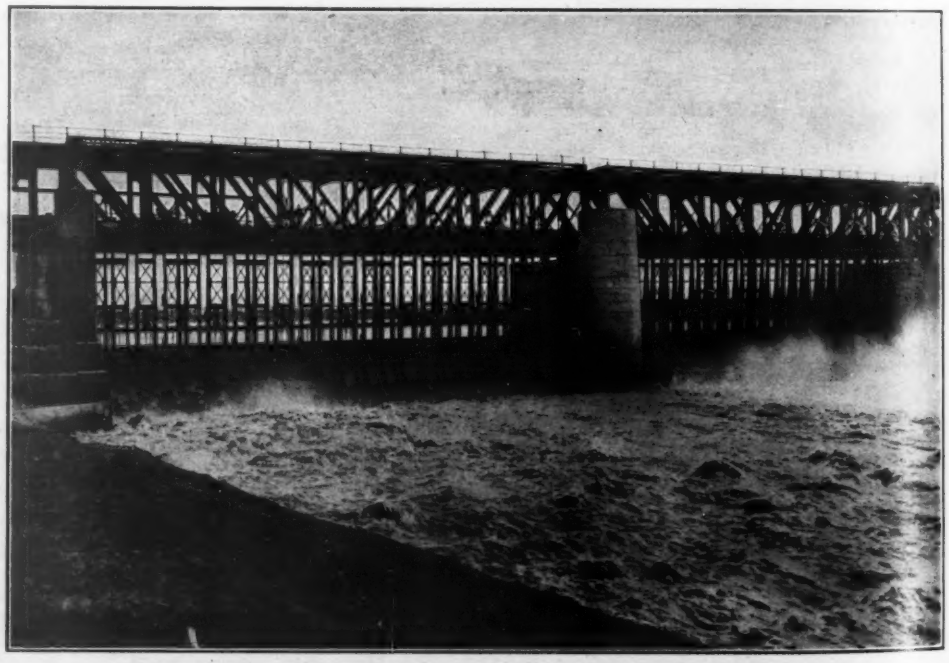


FIG. 7. VIEW OF LOWER SIDE OF DAM WITH CURTAINS DOWN.

but water. All rock that could be loosened by a pick or bar was taken up.

Temperatures were carefully recorded by means of self-registering thermometers placed in lock boxes in various places and read by the inspector. The average temperature in the enclosure was about + 50° F., going down in the most severe weather with wind to + 38°, but at no time during the laying of concrete or for several days after was the temperature allowed to go down to freezing point in the enclosure.

After the completion of a section the boiler was removed to the next and the bulkhead between the new section and the finished one knocked out so that heat might remain on the finished surface for several days. A wearing surface of granite concrete was put on the submerged dam, the thickness varying from 1 to 3 ft. The steel step-socket castings to support the frames of the movable dam were set in the top of the concrete. These castings, weighing about 1,700 lbs. each, were bedded to a depth of 3 ft. in the concrete and are true to within ⅛-in. in any direction.

On account of the destructive nature of the spring break-up, it was imperative that all housing, machinery, plant, etc., be removed before that time.

In the winter of 1908-09 the section in the center of the river (9,000 cu. yds.) was built, as during the year previous the west section had been. In the latter winter it was deemed expedient, for economy in heating, etc., to carry on the work night and day with a complete double shift. That the contractor was justified in adopting this method was proved by results. Aside from the question of economy, which required no figuring, the laying of concrete was continuous and the finished work monolithic. With the warm material always coming in there was, at no time, much steam heat required after the first thorough heating, to remove the frost. The concrete set up better than during the previous year and conditions were more favorable for securing good work than during the heat of summer.

TEMPERATURE OF SETTING CONCRETE.—Some records which were obtained in setting concrete under varying conditions may prove of interest.

A pipe with closed bottom and a screw top was placed low in the concrete, a thermometer being suspended inside from the screw top. As the wall or structure came up, additional lengths of pipe were added. For the sake of comparison the results in the accompanying table are given for three different parts of the work showing considerable range of condition of laying. In this table (A) is the pivot pier of lock, a heavy mass of lock wall 35 ft. high and built in summer, during August, 1907; (B) is submerged dam, Span No. 1, winter work, January, 1908, working 11 hrs. a day, and (C) is submerged dam, Span No. 4, winter work, January, 1909, working night and day. The amounts of concrete in the whole work are, approximately: in lock, 17,300 cu. yds., in dam and abutments, 25,000 cu. yds. and in entrance walls, 7,500 cu. yds., making a total of 49,800 cu. yds.

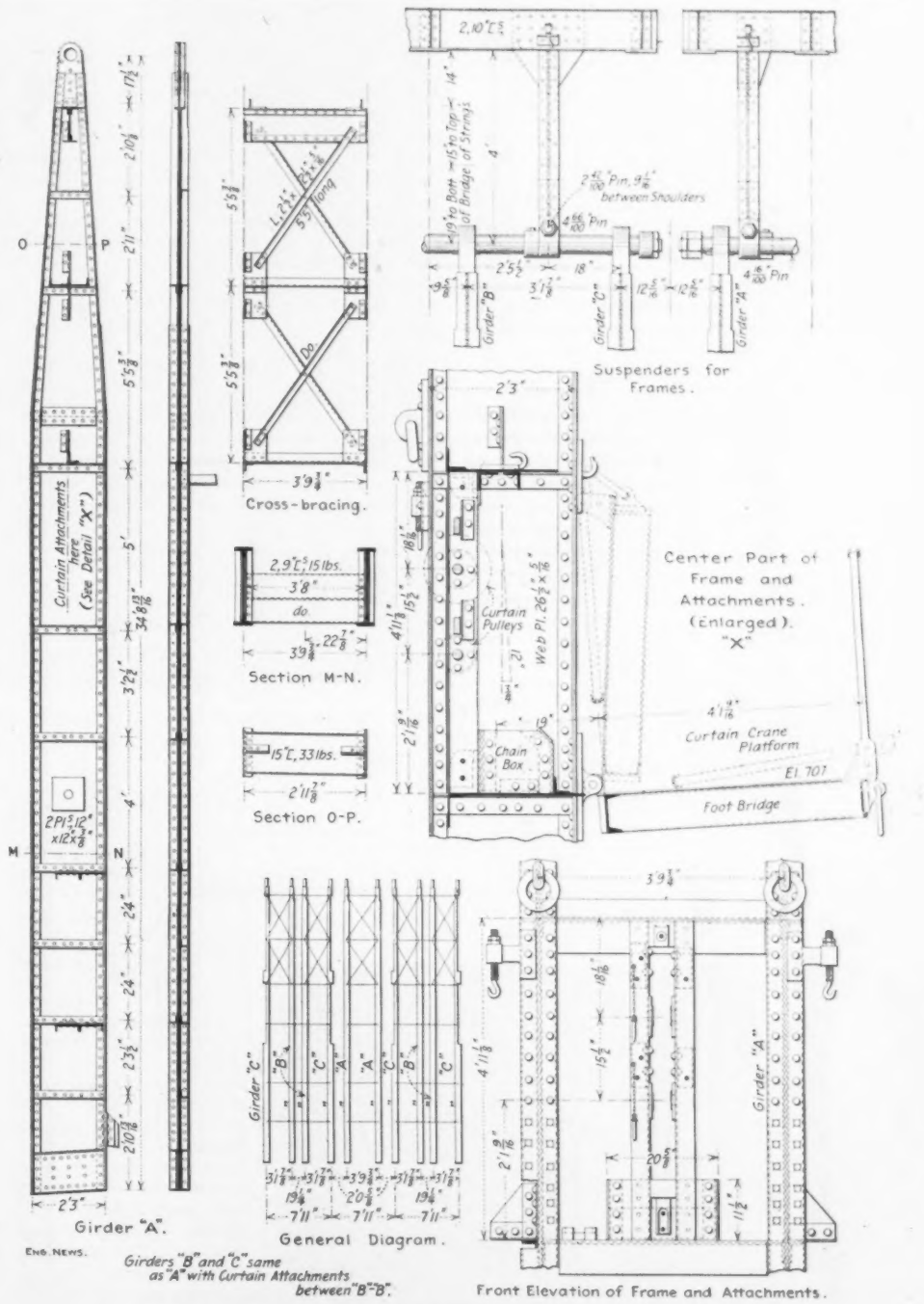


FIG. 8. DETAILS OF MOVABLE FRAMES SHOWING CURTAIN ATTACHMENTS.

TABLE SHOWING VARYING TEMPERATURES OF SETTING CONCRETE.
(Fahrenheit Degrees Above Zero.)

(A) Pivot Pier, built Aug., 1907.

Date, 1907.	Temperatures In pipes.	Temperatures In air.
Aug. 28	Pipe set	65
Aug. 29	82.5	64
	84	69
	86.5	64
Aug. 30	82.5	68
	86	76
	91.5	66
Aug. 31	96	74
	98	77
Sept. 2	99	60
" 3	104	64
" 9	108	..
" 11	108	..
" 12	105	..
" 19	110	..
Oct. 11	102	..
Nov. 5, 1908.	82	..
Aug. 16	49	65
Aug. 29	51	..
Sept. 25	52	43

(B) Span 1 of Dam, Winterwork, 11-hour day.

Date, 1908.	Temperatures In pipes.	Temperatures In air.
Jan. 18	Pipe set	(50)
" 19	65	..
" 20	75	..
" 21	77	..
" 24	76	..
" 27	78	..
Feb. 5	78	..
" 8	78	..
" 9	76	..
" 10	76	..
" 12	75	..
" 18	70	..
" 22	65	..
" 26	65	..
" 29	63	..
Mar. 2	62	..
" 4	61	..
" 6	60	..
" 9	57	..
" 13	54	..
" 17	50	..
" 24	45	..
" 31	42	..
Apr. 3	42	..
" 6	40	..
" 8	39	..
" 9	38	..

Reading stopped by flood.
Aug. 16—Pipes 62; Air 65; Water 67.

(C) Span 4 of Dam, Winterwork, working night and day.

Date, 1909.	Temperatures In pipes.	Temperatures In air.
Jan. 20	Pipe set	53
" 21	72	..
" 22	80	..
" 22	83	..
" 23	86	..
" 23	87	..
" 24	88	..
" 24	110	..
" 25	111	..
" 26	110	..
" 26	110	..
" 27	108	..
" 30	80	..
Feb. 2	80	..
" 3	80	..

The cement used averaged somewhat less than 1.25 bbls. per cu. yd. The cost of the winter work was found to be approximately $1 per cu. yd., more than the same class of work in the summer, although, taking into account the increased cost of unwatering in the latter season, the balance stands in favor of the winter work.

There were used over 61,000 bbls. of cement in the whole lock and dam. A testing laboratory was established on the site of the work, and all cement was subjected to all the tests of the American Standard Specifications, adopted by the American Society for Testing Materials, a sample being taken from every tenth barrel or oftener if thought necessary. The information thus obtained was found of the greatest value in being able to place the best shipments where the greatest strength was required. Tests were also made from time to time on samples of concrete taken from the mixers. Proportions of cement, gravel, stone and sand were determined by void, screening and mixing tests.

Movable Dam.

The following is a list of elevations of structures and improved levels given for comparative purposes:

Normal water of lower pool	Elev.	686
Low water in lower pool	"	681
New level of upper pool	"	703
Lower miter sill	"	672
Upper miter sill	"	686
Coping of lock	"	707
Top of stationary dam	"	690.5
Bridge seat of piers	"	723.8
Top of concrete rest pier	"	735.8
Working floor of movable dam	"	730.6
Main floor of movable dam	"	727.36
Footbridge for curtain cranes	"	707

The supporting structure of the movable dam consists of six steel truss bridges 126 ft. 8 ins. c. to c. of end posts, each span having three trusses which, for purposes of description, are designated "A," "B" and "C" (Fig. 8). These bridges rest on the piers and abutments at elev. 723.8 and support the swinging frames of the movable dam and admit of the frames being swung up to a horizontal position underneath the truss, well above the water surface at its highest stages.

A seventh span of the same length as the others extends beyond the east abutment to a land pier. This span has but two trusses in line with A and B, and gives the means of communication between the dam and the repair shop, besides forming another span of the highway floor which has been placed overhead between trusses A and B.

During the winter, or when the frames are swung up, trusses A and B are about equally loaded bearing the weight of the frames, and the concrete highway floor. Truss C, at that time, has little load aside from its own weight, but when the dam is down, this truss shares with truss B the weight of the frames. By cross-bracing between these two trusses it is possible to have the space between A and B free of cross-bracing to permit of the operation of overhead and trolley cranes for handling frames and curtains.

The side thrust of the top of the frames is carried into the two down-stream trusses, thence to the rest pier through a bearing on the side of truss C at the elevation of the main floor. The rest pier is reinforced by means of two 15-in. channels connected by seven rods of 2-in. diameter and tying it into the main pier (Fig. 6). Rods 1-in. square and 40 ft. long and 18 ins. c. to c. are bedded 6 ins. beneath the bridge seat and turned up into the rest pier. The side thrust at the bottom of the frames is taken up by the step-socket casting previously described. Both the main and the working floors of the bridge are fitted with steel coverplate floors, the rivets being countersunk on the working floor. Service track and cars are provided on the main floor.

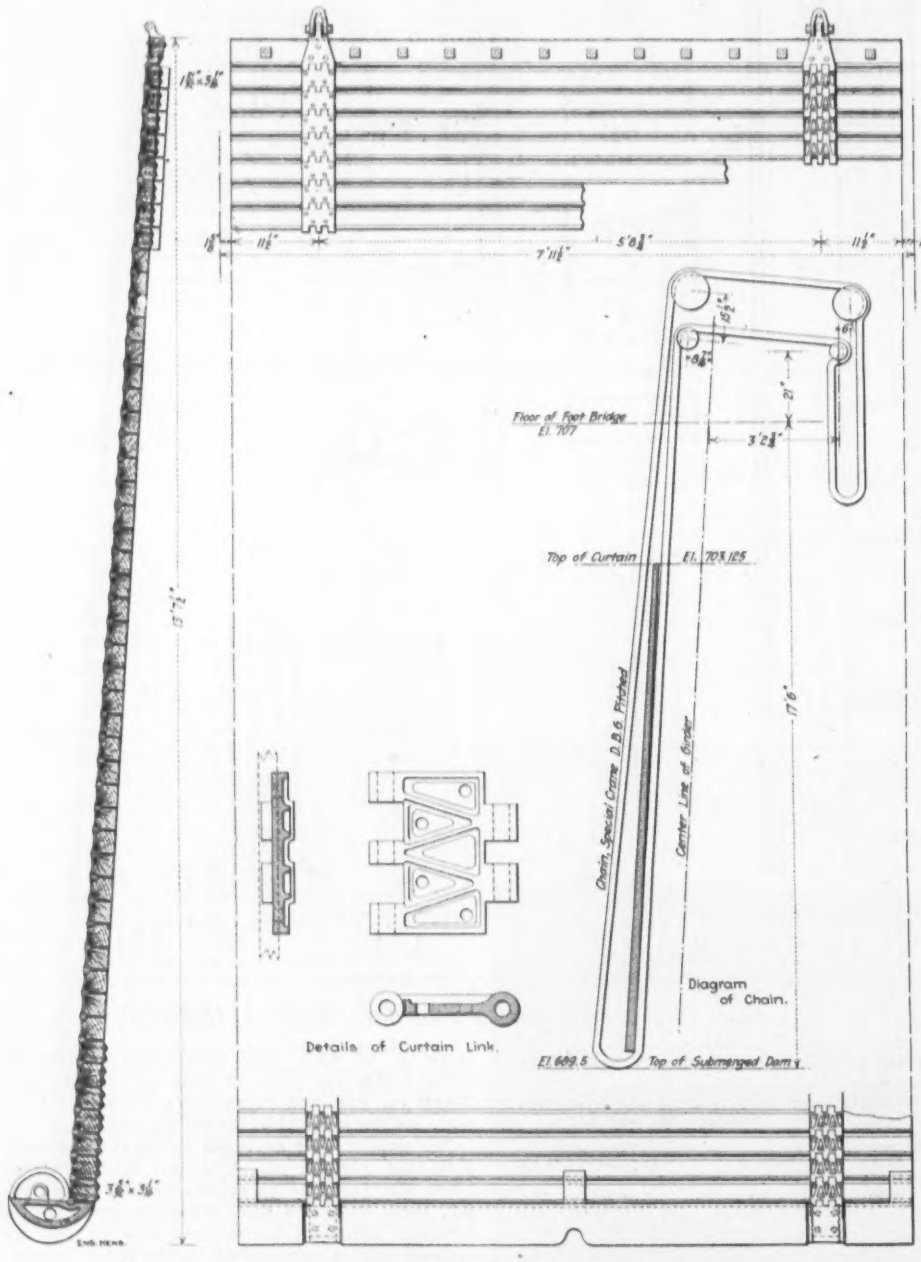


FIG. 9. DETAILS OF CURTAIN ON ST. ANDREWS MOVABLE DAM.

The half-tone and drawings will sufficiently describe the working floor.

CURTAIN FRAMES.—The frames are made of special built-up girder beams (Fig. 9), fully assembled, and riveted up before shipment. They are suspended beneath the main floor on hangers resting on step castings and, by means of steel wedges, adjustment may be made in either direction. In this manner the final adjustments are made after hanging. It was found that for curtain support and for the general operation of the dam that it was best to assemble the girders into groups of two and four alternately, the assembled member being designated as a frame. The frame consisting of four girders complete weighs about ten tons.

Cranes for operating these frames move on a track along the up-stream side of the working floor. The lifting chain attached to the frame has a ring and block at the end. When the frame is up the block is supported by a steel forging bolted, at one end, to the working floor, and, after swinging it beneath the chain block, it is bolted at the other end. To lower the frame the crane is attached to the ring and the block lifted enough to swing the forging free from underneath, permitting the block to pass through the floor. The crane then pays off chain till the frame rests against the step casting of the submerged dam. In raising the frame, the crane chain is paid off and attached to an auxiliary swinging chain to carry it over towards the frame. The swinger is attached to the crane-chain, from a small platform beneath the floor. Then as the crane pays off the two chains swing across beneath until within reach of a man on the frame, who hooks up the crane to the frame and releases the swinger. There are 15 frames in each span, 90 in all, 48 large and 42 small ones. There is also one extra of each size in the yard.

CURTAINS.—The curtains are suspended from hooks on the face of the frames and are so adjusted that when rolled down to their full extent, they make a closure with the concrete of the submerged dam. The operation is effected from a folding footbridge on the back of the frame at the elevation of the lock coping, an electric crane passing along a track on the footbridge. Passages are left through the piers to permit the cranes to pass from one span to another. Turntables in the center of alternate piers with short side runways give storage for the cranes in winter or if not in use. The chain travel from crane to curtain is shown on Fig. 10.

The curtain itself is made up of 50 laths of long-leaf southern pine and assembled as shown in Fig. 9. The wood was subjected to a treatment with creosote for preserving it against the action of the water. The links connecting the laths are of brass composed of 10 parts of tin, 2 parts of zinc and 88 parts of copper. The material is required to stand an ultimate tensile strain of 28,000 lbs. per sq. in.; and finished links, when tested, must have a breaking strength of at least 20,000 lbs. per sq. in. The pins connecting the links are of phosphor-bronze. The toe roller is a casting attached to the bottom of the curtain. It gives the proper impetus to the curtain in rolling down against a pressure-head so that the curtain will be carried to the extent of its travel.

Before shipping out, complete frames were set up in the shops, carefully adjusted to position, and all curtains, after being fully assembled, were placed on the frames, trued up in working position, rolled up and down and operated to the satisfaction of the shop inspector. There are 15 curtains in each span, 90 in all, and 20 spares ready for use to be stored in the repair shop.

Guide angles on the face of the frames assist in keeping the curtain in its proper position when rolling up or down. At the side of each pier a small space between the frame and the concrete of the pier is not closed by the curtain. To effect closure at these places round wooden poles of sufficient diameter are shoved down the face of the frame.

CRANES.—The installation of cranes for the complete operation of the dam and repair shop is as follows:

FIG. 10. VIEW OF WORKING FLOOR OF ST. ANDREWS MOVABLE DAM, SHOWING CURTAIN OPENINGS, CHAIN BLOCK FORGINGS BETWEEN RAILS, SUPPORTING FRAMES, CRANE TRACKS, ETC.

(1) Four overhead traveling hand-power cranes: two of capacity four tons; two of similar type but designed to lift together, at the same time and speed, two loads situated at a distance of 4 ft. 9½ ins., at right angles to the bridge of the crane.
(2) Traveling crane in repair shop of 2-ton capacity.
(3) Traveling crane in dynamo room of 2-ton capacity.
(4) Two cranes on working floor having two sets of sprocket wheels, for lifting the double frames. Equipment of each consists of one 20-HP., 230-volt motor for hoisting, and one 2-HP. motor attached to the trucks. An automatic load brake controls the speed of lowering, the controller being operated by man on footboard of crane. Each crane is provided with automatic and adjustable cut-offs of the current, to shut off the power before the frames reach either end of their travel. The crane is supplied with power by means of an overhead trolley bar the trolley wire being stretched along truss A.
(5) Two cranes of similar construction and operation as the large ones but having only one chain attachment; and one 10-HP. motor. These cranes, which are for lifting the smaller frames, are light enough to be moved by hand without difficulty, or may be hitched tandem with the large crane. These cranes are shown at "R," Fig. 5.
(6) Three electric cranes for hoisting and lowering the curtains. They operate along the footbridge on the lower side of the frames and are easily moved along by hand. Equipment consists of one 2-HP. motor, 220 volts and controller. Cranks are provided so that they may be operated by hand and all ordinary regulation may be effected in this way without steaming up the power plant in the repair shop. The power is brought to these cranes through conduits running along the under side of the main floor, leads going down the frames, as often as required, to receptacles within easy reach of a man on the footbridge. Each crane is fitted with 25 ft. of flexible cable terminating in a plug to connect up to the nearest receptacle. The cranes can be run out under Span 7 and put on the track leading to the shop, where they may be taken for storage or for repairs.

WIRING.—The installation provides either for the generation of the power or for its importation. All wiring is in accordance with the fire underwriters' specifications. There are no bare wires except the trolley wire. The electric equipment and all the wiring has been done by the Canadian General Electric Co., and the work has been done throughout according to the best modern practice.

REPAIR SHOP.—The shop is placed a short distance to one side of Span 7 and serves the double purpose of power-house and repair shop. It is connected with the dam by a service track. The equipment consists of:

Canada Foundry Co. boiler, 735 sq. ft. of heating surface; one Champion forge; one Safford heater with radiator system; Robb-Armstrong engine direct-connected to 40-KW. Can. Gen. Elec., 250-volt, direct current generator; motor generator set having 60-HP. motor, and direct current 40-KW. generator of 2,080 volts; switchboard having three panels and feeder panel to be provided with three main switches so that the current may be switched to motor in shops, curtain, cranes and trolley for frame cranes; two 2-ton overhead traveling cranes; one double cross-cut saw; one self-feed rip saw; one wood-boring machine; 12-in., four-sided molder for curtain laths; one 16 × 8-ft. standard engine lathe; one double emery grinder; one 20-in. lever and worm feed drill press; one direct-current motor capable of operating all machines at the one time.

Spare curtains are stored in the shop.

The building is of brick with concrete gravel roof. A well has been bored inside the building. Coal and stores are placed in a separate building near the door of the boiler house.

OPERATION OF DAM.—During the summer and fall of 1909 the erection of the steel was practically completed. Timber falsework was put up on the submerged dam and the truss bridges completed span by span. The frames were then brought out on a derrick scow and suspended from the hangers. After adjustment by means of the steel wedges, they were swung up beneath the working floor and secured for the winter. Before the opening of navigation this spring, all the curtains were lowered from the working floor on the frames and made ready for operation. Cranes were also installed and connected up and the frames were lowered on the 26th, 27th and 28th of April, a rise of about 15 ins. above the dam resulting. On the following day the rolling down of the curtains was begun. On the 30th it was necessary to raise some of the curtains to check the rise, the water having risen over 9 ft. in one day.

The regulation was under perfect control on May 2 and the lock was opened by the passage of the government steamer "Victoria." Since that date the upper pool has been maintained by hand operation of the curtain cranes, and for several days not one curtain was moved.

For the first few days of the raised levels there was considerable leakage between the laths of the curtains. This has gradually decreased till in many places there is almost no leak, the face of the curtain being silted with weeds and dirt, but not enough to interfere with the rolling up. It was found necessary to place a glance boom above the dam by which all floating material is collected in a pocket on one side and removed. The accompanying views show the dam in operation after the opening of navigation. During the first few days a few of the curtains were all the way up and the remainder entirely closed. Gradually they have been all rolled down from the top and additional opening made at the bottom, the intention being to regulate by means of narrow openings at the bottom. By thus increasing the head on the opening, the total freeway has been decreased from more than 2,200 sq. ft. to less than 400 sq. ft. without any falling off in the flow of the river.

The lock, dam and canal will be lighted, the repair shop being now equipped for electricity. A system of telephones is being installed connecting up the dam and repair shop.

The top of the trusses of the movable dam has been utilized as a highway. The roadway consists of transverse concrete arches reinforced with ¾-in. rods and covered with asphalt. The lock will be spanned by a bascule and the approaches, not yet completed, will be of light steel construction on concrete footings.

The grounds about the lock and dam are now in process of being converted into a park and in a short time this will form the most attractive summer district about Winnipeg. Already the traffic on the river has felt the effect of the new condition and capital has begun to reach out into a new field.

The progress of the work from start to completion was most gratifying and the character of the work testifies to the desire of all those connected with it to secure good and durable con-

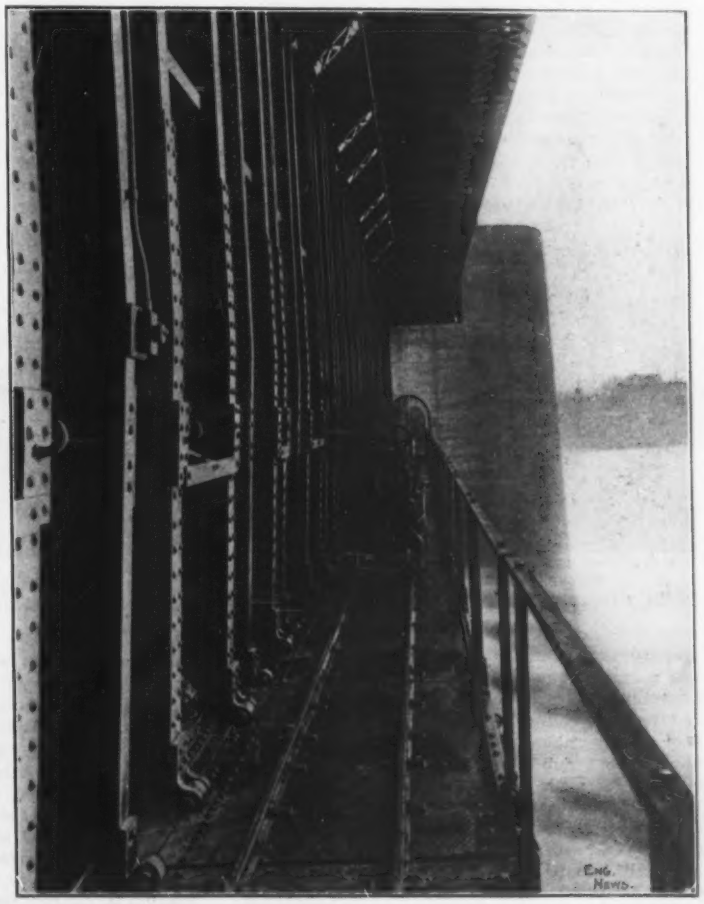


FIG. 11. VIEW OF DOWN-STREAM SIDE OF THE MOVABLE DAM, SHOWING CRANES FOR RAISING AND LOWERING CURTAINS.

struction. The staff of engineers engaged in the supervision of construction were A. R. Dufresne, District Engineer of Manitoba; E. A. Forward, Engineer-in-charge; E. S. Miles, 1st Assistant, and H. G. Kerrigan, 2d Assistant.

Under the direction of Mr. A. St. Laurent, Assistant Deputy Minister, the steel bridge and movable dam was designed by H. E. Vautelet, C. E.; the lock, substructures, approaches, wingwalls, etc., by A. R. Dufresne, District Engineer of Manitoba, and E. A. Forward, Engineer-in-charge.

The lock, piers and substructure is one of the finest pieces of concrete work on the continent, and everything is being finished up according to the high standard of the Canadian canals. This contract, including foundations, concrete structures, excavation, approaches, retaining walls, slopes and grades, etc., was executed by Messrs. Quinlan & Robertson, Montreal, Mr. Thomas Lowe, Superintendent.

The steel work comprising bridge structure and movable dam was fabricated and erected by the Canada Foundry Co., of Toronto. Much of the work was special in character and design. The company spared no effort to make the work of a high order, and the ease with which all parts of the erection proceeded to a finish was ample proof of the extreme care in fabrication.

The inspection of shop and mill work and of erection was performed by the Canadian Inspection Co., of Montreal.

The formal opening of the lock took place on July 14 of this year, when Sir Wilfred Laurier presided at the exercises.

A Novel House and Street Sewerage System for Portions of Manila, P. I.

By GEO. H. GUERDRUM.*

It has become necessary to develop a form of sanitation in certain outlying sections of Manila which in some ways is at variance with sanitation as practiced in occidental and temperate zone cities.

The continuous agitation by the Bureau of Health for the Philippine Islands for street extensions and sanitary barrios is largely the result of an effort to provide healthful building sites for that large proportion of the Philippine population which from poverty or other reasons is compelled or chooses to live in typical nipa palm leaf houses common to the Islands.

These houses, built entirely of nipa and bamboo, and costing often less than P50 ($25) to build, are, as a general rule, unprovided with plumbing or drainage facilities of any sort, and have been the common type of house construction in the Philippines as well as in many other oriental and tropical countries for many centuries. The floor of the house is about 1½ meters (8 ft.) above the ground level. Waste water is discharged through slat floors directly onto the ground underneath the house, where various domestic animals, such as pigs and chickens, act as scavengers. As a rule, the houses were built in small groups or "barrios" (villages) without reference to street lines or other avenues of approach.

This old system, in spite of its insanitary features, has been more or less adhered to and tolerated in outlying sections and the interiors of large blocks for generations past. While considerable study had been given to the subject for many years, it was not until the cholera outbreak of 1908 that a policy tending to radically change conditions then existing was outlined, and which has now through the efforts of the Bureau of Health been definitely adopted by the Municipal authorities.

Sanitary barrios, as now being built, consist of a system of permanent street lines or city blocks laid out on the regular street plans of the municipality. These blocks are then divided into house lots. Every lot must face either on a street or an alley way and only one house is permitted on a lot. The drainage, instead of being collected in sinks and other plumbing fixtures and passed through the plumbing system to the street sewer, as it is customary in houses of strong material, is allowed to pass through the slat floor of the house to the ground surface, where it is caught in an open cement-lined basin. This basin slopes towards a small cement-lined open canal which may be easily swept out and cleaned. The small canals lead from each house to larger street canals, also cement-lined and open for inspection and cleaning purposes, as well as for the purpose of permitting the purifying action of the sun and daylight to take place.

Another reason which has caused the development of the sanitary barrio by the Bureau of Health has been the low street mileage in proportion to the population: only 95 miles of streets in Manila to 234,000 population, or one mile to 2,467 inhabitants. [The figures are all the more striking in view of the fact that a large percentage of the buildings are only one story in height.—Ed.] With these congested conditions the Bureau found it useless to try to correct conditions until it had more ground on which to put ejected occupants of insanitary houses, as no improvement of conditions could be obtained by driving people out of one neighborhood only to have them drift into a worse one.

The San Lazaro Estate, owned by the Insular Government and administered by the Bureau of Lands, is now about completed as a sanitary barrio.

Begun in October, 1908, with an experimental appropriation of P5,000 ($2,500) the work has recently been completed at a total cost of P34,-117.82. Forty-five blocks consisting of a total of 1,648 lots, with provisions for a population of 13,184, are in operation. Street canals carry house drainage and public midden sheds receive human excrement in this area. A public water hydrant is placed conveniently to every block.

Fig. 1. Minor Sewer or Canal.

Fig. 2. Main Sewer or Canal.

OPEN CEMENT-LINED SEWERS SERVING THE NEW SANITARY BARRIOS OR HOUSE GROUPS, MANILA, P. I.

Interior and indiscriminate barrio construction has now been definitely discontinued by an ordinance of the Municipal Board, passed Sept. 21, 1909, at the request of the Bureau of Health. From the date of the passage of the ordinance all new houses must abut on some form of street either public or private. The ordinance reads as follows:

ISSUANCE OF PERMITS.—When application, plans and specifications, conform to the requirements of the title and of title eleven hereof, the engineer shall issue a permit for the erection of the building and shall approve such plans and specifications in writing, provided that the building shall abut or face upon a public street or alley or on a private street or alley which has been officially approved. One copy of all approved plans and specifications shall be returned to the owner or his agent, and one copy shall be retained by the engineer.

One of the chief difficulties in the adoption of this form of sanitation has been the low nature of the ground to be drained. Most of the so-called high land of Manila (land elev. 1 to 2.5 meters above high tide) was taken up by better class of dwellings many years ago, leaving the lower areas to be settled *en bloc*, without any form of sanitation, by the poorer element of the municipality.

In order to get the necessary fall to the drainage system, therefore, use had to be made of the low-water elevation of the numerous tidal *esteros* with which Manila is threaded. The outfall of all sanitary barrio drains, where they empty into the estero, runs from 0.0 meters above low tide to 0.5 meters above low tide. Mean high tide has an elevation of .762 meters. Main drains have a grade of .002 (2 per 1,000), while side drains have a grade of about .004 (4 per 1,000).

The above-described system is of course not applicable to the business and better residence sections of the city, where the new sanitary sewer is in operation and municipal sanitation is much the same as in American cities.

Subsidence Over a Tunnel, and Reconstruction of a Destroyed Building Foundation.

About as desperate an underpinning job as ever occurs had to be carried out in Chicago six years ago. The work is described for the first time in a paper just published,* by Mr. J. E. Davidson, one of the engineers who directed the work.

The building in question, at 385 Fifth Ave., near Harrison St., Chicago, is five stories in height, 90 ft. front by 100 ft. deep, facing west. The southerly half was built in 1871. The northerly half was built in 1902 to 1903, and this is the portion which gave trouble. The wall footings and interior columns of this portion rest on piles having approximately 30 ft. penetration. Immediately after completion the entire building was occupied by the Troy Laundry Machinery Co. for machine-shop purposes. The operation of planers, etc., in the building caused a considerable degree of vibration, which may have had something to do with the settlements which soon appeared, and with the entire subsequent foundation trouble.

As was learned later, the old Polk St. tunnel of the Chicago water supply system crosses diagonally under the lot at a depth of about 60 ft. below ground surface. It is a circular brick tunnel of 7 ft. inside diameter. When the presence of this tunnel became known, it was at once suspected that some of the piles driven to carry the walls and column piers of the north half of the building had penetrated the tunnel wall, thus making holes by which the water was able to work into the surrounding ground and the earth find its way into the tunnel. This was fully verified subsequently. That under these conditions the building was gravely threatened is self-evident. This tunnel is now abandoned, a new one following the lines of the streets instead of crossing under the blocks having been completed in 1907. The new Blue Island Ave. tunnel also was built under the streets in order to avoid the liability of damage to the old tunnel by building foundations. These two tunnels were described in our issue of Nov. 14, 1907, and Oct. 22, 1908.

Subsidence of the basement floor of the newer half of the building developed soon after it was occupied. A large amount of filling was done, after a time more or less continuously, to keep the basement floor surface up to grade. Nine months after the building was occupied, the sewer lateral of the building broke, thus showing that the ground movements were extensive. At that time also a settlement of about an inch was observed in certain of the columns. Shortly afterward an engineer (Mr. John H. Sutter, who retained Mr. Davidson to assist) was employed to investigate the matter and direct repairs. This was in February, 1904.

*Chief, Division of Sanitary Engineering, Bureau of Health, for the Philippine Islands.

*"Underpinning a Factory Building," Journal of the Western Society of Engineers, August, 1910, pp. 479 to 491.

The first examination showed the total amount of subsidence to be of very serious proportions, as indicated by about 14 ft. of settlement of the basement floor at the worst point. The soil and the cinders which had been used to fill the hole were saturated with water. That this water came from the tunnel, or, rather, that a water tunnel passed under the lot, was learned only after some investigation of city records, and from these records it was also learned that the top of the tunnel was some 5 ft. higher than the average elevation of points of piles, making it practically certain that the piles had damaged the tunnel. An old working shaft of the tunnel was found nearby, but an examination made here by a diver showed only that there were extensive deposits of mud in the tunnel.

As the tunnel was in continuous use, with water flowing through under pressure and at considerable velocity, there was every reason to fear rapid progress of the settlement and disaster to the building. It was at once decided to get the building on blocking and jack screws as quickly as possible to be prepared for any emergency. This was carried out. It proved to be a difficult and anxious task, especially because of the cast-iron columns in the basement, which might be cracked unless the settlement were very closely controlled. Even while setting the blocking for the interior columns, slow but continuous settlement of the walls and columns was observed, and at the same time the column foundations showed a decided lateral movement as though the piles under them were deflected. In less than a month after the first examination, the shoring was complete. But hardly was the blocking in place, taking the load off the column foundations, when rapidly increased settlement of the basement soil occurred, extending also to parts of the basement not previously affected. Widening the spread of the blocking did not help much, and the walls of the elevator and stair well at the rear of the building were therefore torn out. Before the whole north half of the building had been fully transferred to jack screws and blocking, part of the stair wall footings had settled as much as 7 ft., two of the column footings had settled 4 ft., and one of the cribs supporting shoring beams had gone down 14 ft., all these figures being for a period of time less than one month. As soon as everything was on screws, however, it was possible to follow up the movement so closely that no dangerous or unequal settlement of the superstructure resulted at any time during the subsequent operations. In fact, the occupants of the building continued at their work almost undisturbed, all the machinery being kept in operation.

Plans for a foundation of cylinder piers to rock, for supporting a girder system to carry walls and columns, were then worked out. The piers were to be sunk on either side of the tunnel, and at least 4 ft. distant from outside of brickwork. The total depth of rock was 95 ft. below street level, so that the piers would have to go down about 35 ft. below the top of the tunnel. It was planned to use the method common in the Chicago clay, of digging carefully lagged open wells to subgrade and filling them with concrete.

One well was successfully put down by this method, although the soil was soft and watersoaked to a very troublesome degree. The second well which was started proved impossible, however. Water, swelling and flowing soil, deformation of the lagging and the influence of the soil pressure induced by the load on the cribs nearest the well (which, during this period, sometimes settled as rapidly as 1 ft. per day), and lateral shift of the lagging, proved insuperable obstacles. Finally, an inrush of water, evidently direct from the tunnel, made it necessary to abandon the well and quickly fill it to prevent collapse.

It was then decided to close the gates of the tunnel and pump it out before attempting to sink the other wells. There was much trouble and delay in accomplishing this, as provision had to be made for substituting a supply from other mains for that cut off by closing the tunnel. During this delay a third well was started, but it also had to be abandoned after striking some of the adjacent piling, which had deflected materially from the vertical, and by having large quantities of water enter from the tunnel. Wells remote from the tunnel, however, were sunk with no particular difficulty, apart from some trouble caused by the extremely soft condition of the clay.

On June 21, 1904, pumping out the tunnel had been started, and it was possible to set to work again on the well first abandoned (just about three months before). The new lagging was started on a somewhat larger diameter. The work was difficult, but the well was brought down to rock in 15 days. When passing the tunnel the lagging only just cleared the brickwork. The second well abandoned was next taken in hand, and it was also completed in two weeks. This well, however, actually intersected the tunnel by a width of 18 ins., showing that the location of the tunnel was recorded several feet in error.

By this time the most serious work on the new foundation had been accomplished, the piers for the main girder system being completed. The originally planned system of wells was materially extended, however, as a result of the conditions found, by further cylinders sufficient to enable practically the whole north half of the building to be carried on the piers. To complete the reconstruction, it was also necessary to jack up the interior columns of the south half of the building which had settled from 2 to 4 ins.; in fact, Mr. Davidson states in the paper mentioned that the effects of the settlement were noticeable within a radius of about 100 ft. from the tunnel.

When the work on the building itself was completed the tunnel was entered and cleaned out, and it was then seen that "a great number of piles had penetrated the brickwork." The piles were cut out and the holes bricked up, the damage to the tunnel being much less extensive than might have been thought. It is stated that

> These piles were not broomed in encountering the brickwork of the tunnel and, in fact, were in no worse condition than would be expected after a pile had been driven through 50 ft. of firm clay.

The whole operation cost about $325,000, it is stated. The city of Chicago paid the bills.

A SMALL GERMAN NICKEL-STEEL BRIDGE is mentioned in "Der Eisenbau" of August, 1910. It is said to be the first bridge of this material in Germany. The span is 103 ft., depth of truss 13 ft., panel-length 10.3 ft. It is on the line of the Prussian Railways between Oberhausen and Dorsten. The structure weighs 65.5 tons, of which 55 tons is nickel-steel.

A Combination Concrete Dumping Bucket and Dump Car.

An interesting novelty in equipment for handling concrete is a combination car and bucket for transporting and depositing concrete. It can be used also in the handling of material. The bucket is of the drop-bottom type, with a bail, and has attached to each end a segmental shoe; when the bucket is lowered upon the car frame, these shoes rest upon suitable supports. In this position it can be used as a bottom dump car or a side dump car. Fig. 1 shows the bucket swung clear of the car, and with the bottom doors open. Fig. 2 shows it in use as a side dump car.

The door-operating mechanism is said to be exceptionally simple. A swinging lever (A), which extends across the width of the car, has its ends slightly cranked, and from each cranked end is hung a vertical lever (B) to which the two door levers (C) are attached. With the doors closed, the lever lies against the side of the car. By raising it to the position shown in Fig. 1 the doors are opened. When returned to the normal position it closes and locks the bottom, without the use of pins, triggers or springs. With the bottom closed, the levers are on a dead center, and the load has no tendency to open the door. The bottom dumping (either as a car or as a bucket) is very convenient for delivering concrete directly into the forms. In narrow forms also, the doors act as guides, preventing the waste or spilling of concrete. It will be seen that the concrete can be dumped from the car running on a track over or beside the forms, or from the bucket when handled by a crane or derrick.

When used as a car, it can be dumped on either side (as well as at the bottom), but the body is latched to prevent rocking while it is being hauled on the track. The bail can be removed if it interferes with the use of the car. If desired, the body (or bucket) can be transported on a flat car instead of on its special car frame. The bucket is of 3/16-in. steel, and has a capacity of 21 cu. ft. The car has 12-in. wheels for a track of 24-in. gage.

Fig. 1. As a Dump Bucket.

Fig. 2. As a Side-Dump Car.

A COMBINATION CONCRETE DUMPING BUCKET DUMP CAR.

(J. L. Blaker, Blaker Mills, W. Va., Inventor.)

This car has been used on the construction of a concrete dam 75 ft. long and 14 ft. high. The concrete (1:3:6) was mixed by hand on a platform near one end of the dam, and the loaded car was run out on a track built over the forms, the bottom being dropped to deliver the concrete in place. The car can be used also for handling gravel, stone, sand, etc., on construction work.

This device is the invention of Mr. J. L. Blaker, of Blaker Mills, W. Va., and arrangements for its manufacture have been made with the American Car & Foundry Co., of Huntington, W. Va.

Erection and Elevation of a Double-Track Drawbridge Under Traffic.

By W. L. SIX,* M. W. S. E.

The Bridge and Building Department of the Chicago, Milwaukee & St. Paul Ry., under the direction of Mr. C. F. Loweth, M. Am. Soc. C. E., Engineer and Superintendent, has recently replaced an old draw span over the Kinnickinnic River at Milwaukee, Wis., to meet the requirements of heavier loading and wider span channel as planned by the government. The bridge is located in a track elevation district, and its erection and elevation was carried on in conjunction with the other elevation work.

FIG. 1. TEMPORARY LIFT BRIDGE CARRYING TRACKS OF C., M. & ST. P. RY. OVER KINNICKINNIC RIVER DURING ERECTION OF NEW BRIDGE.

The city of Milwaukee put in a bascule bridge 165 ft. away toward the mouth of the river on Kinnickinnic Ave., and the Chicago & Northwestern Ry., whose line crosses this avenue near the St. Paul tracks, 300 ft. north of the site, erected a drawbridge 200 ft. up-stream (Fig 2). This made it very difficult to outline any regular program of erection, at the beginning of the work, since it was necessary to maintain both railway and river traffic, and interrupt street traffic as little as possible.

The new bridge was erected on the center pier of the old span, the old masonry being encased in a new rim and cap of reinforced concrete. The novelty of the methods employed in this work was due to the fact that the old and new centers were coincident and that it was necessary to elevate the new draw 6 ft. 9 ins. after its erection. The total elevation of tracks was 11 ft. 9 ins. At the site 5 ft. of this elevation was made after the old draw was taken out and while the temporary structure was in operation. This was the maximum amount the bridge could be elevated at this time, an amount determined by the greatest rise in elevation on Kinnickinnic Ave. that would not interfere with street traffic and the Chicago & Northwestern Ry. tracks, and by using the maximum allowable grade from this point to the bridge.

The method employed in the recent erection of two draw spans replacing the old swing spans in Milwaukee by the railway company was to cut away the shore arm of the old draw, replacing it with a temporary fixed span, and to operate the channel arm on its old turning machinery by supporting the outer end on a scow. The new span was then erected at right angles to the tracks, allowing trains to pass through the center panel over the drum during erection. But since the center of the new bridge across the Kinnickinnic River was to be directly over the center of old pier, some other method had to be resorted to in this case for keeping the channel open to navigation. This was accomplished by removing the old draw span, erecting a temporary falsework from the near shore to the old center pier and installing a temporary trunnion lift bridge, consisting of a double track 75-ft. deck girder, spanning the channel and lifted from a wooden tower on the far bank of the river.

While the temporary span was in operation, the 5 ft. of elevation mentioned above was made, the old pier was encased with reinforced concrete, and the new span erected at right angles to the tracks, trains passing through the center panel.

Fig. 1 shows the temporary bridge in closed and open position with its tower and lifting apparatus. The tower consists of eight posts, four, on either side of the track, forming a guide for the counterweight. The lifting was done by counterweight, and by one 30-HP. non-reversible engine in the tower with its drum directly over center line of the tracks. The engine cable was a ¾-in. plow steel rope, 1,310 ft. long, running continuously through the four blocks, forming a twelve part line. The counterweight cables were eight ⅞-in. plow steel ropes, four on either side of track, passing over 18-in. sheaves on the top of tower. All lifting cables were fastened to the needle beam (see Fig. 1) running laterally beneath the girders, and located far enough from the tracks to clear all trains.

The counterweight consisted of four wooden boxes filled with sand, each weighing 35,000 lbs. The upper boxes dropped 20 ft. and the lower boxes 45 ft., it being necessary to support them at these points on account of the decreasing load as the span was lifted. A small timber carrier, sufficient in weight to take up the slack in the cables, dropped from this last point to bottom of tower. The cables were connected to a cross beam underneath the carrier by means of four eyebolts, thus providing adjustment to level boxes.

The open position of bridge (Fig. 1) shows the upper counterweight box on a level with engine house and the top of the lower box just above the embankment. In the closed position the four boxes can be seen at the top of the tower.

A 40-in. cast-iron drum was used for engine cable and was geared directly to the drum shaft of the engine. This was done as a matter of safety. When the bridge was lifted it was impossible for it to lower until the valves were released, and the lowering was accomplished with less jar and more safely than it would have been done with the friction brake alone. As the maximum load on drum line was calculated to be 10,500 lbs. when lifting and only 3,[illegible] lbs. when lowering, with any ordinary speed lowering the bridge, there was no danger to the engine by this method.

The two blocks fastening to the tower were held in the plane of the cables by an 8 × 16-in. strut with steel plates strapped on the sides at ends and bolted through the blocks. The four blocks were in one plane and the connections of the upper blocks were made so the whole system when lifting and lowering revolved about a line through the top of the sheave over drum.

The arrangement at trunnion is shown in Fig. 4. The span was supported and turned on four 4-in. pins, one under each girder, with end bearing castings only slightly modified from the St. Paul standard for 75-ft. deck spans. These end bearing castings were bolted to three 8 × 16-in. timbers which served as a girder to carry the backward thrust at beginning of lift to the columns of the tower. The iron castings shown on top and bottom of these timbers served to deliver this thrust and the small flanges on sides of post served as guides to keep the end of span in proper alinement as it was being elevated.

The outer end of span was lined up when lowering by a wooden guide shielded by a steel plate and bolted to pier between the two inner girders.

All work possible, preparatory to the installation of this temporary bridge, was done before the day that the change was to be made. The tower was erected with its counterweight boxes filled with sand, supported in place at the top of the tower, and all cables connected. Falsework bents were driven for the channel approach under the arm of the old bridge opposite the lift, and pony bents were constructed on the bank ready to be set in place. The four 75-ft. girders were assembled and bolted upon

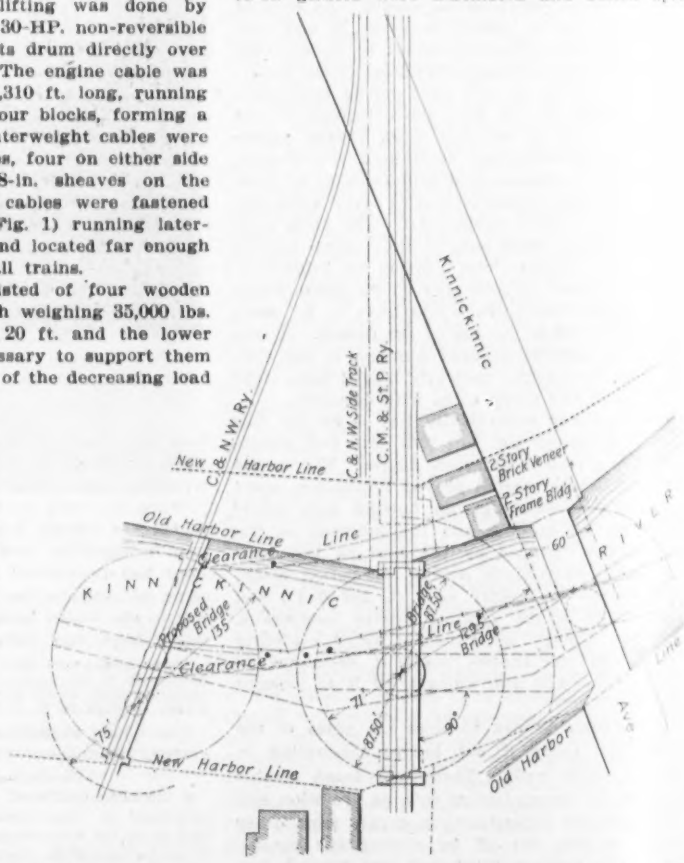


FIG. 2. LAYOUT OF C., M. & ST. P. RY. CROSSING OF KINNICKINNIC RIVER, SHOWING RELATIVE LOCATIONS OF THE THREE BRIDGES.

*Asst. Engr., Wisconsin Bridge & Iron Co., North Milwaukee, Wis.

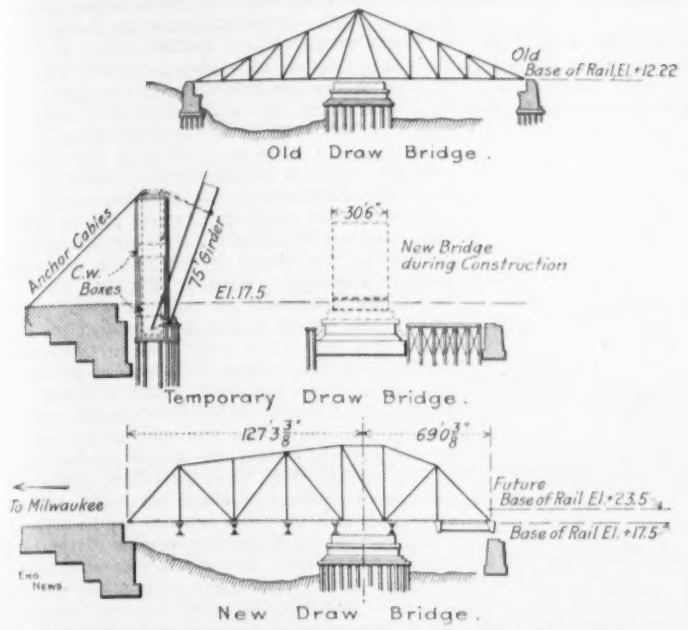


FIG. 3. OUTLINE DIAGRAMS SHOWING OLD, NEW AND TEMPORARY CROSSING OF THE RIVER.

barges with floor system and tracks complete as shown in Fig. 5.

On the day the change was made, the old bridge was swung at right angles to tracks, pins knocked out, and diagonals over the drum removed to clear trains. The pony bents were set into place, the lift bridge floated to position and connected up, the base of rail elevated 2 ft. on the approaches, and track laid connecting up with the lift. Work was begun at 8 a. m. and the bridge ready for traffic at 4 p. m.

It was necessary to calculate the efficiency of the hoisting tackle in order to get the proper threading of the twelve-part line so as to have the load when lifting or lowering as nearly equal as possible at the two points of connection to girders. It was necessary also to get the proper distribution of counterweight, and the elevation at which this should be supported, so as not to overload the engine when lifting and yet have it in a position to be picked up in lowering the bridge. The efficiency of the system was worked out according to the method given by Weisbach's "Mechanics of Hoisting Machinery," the formula for the efficiency of a fixed pulley being

$$\frac{1}{K} = \frac{1}{1 + C\frac{d^2}{r} + 2\delta\frac{P}{r} - \sin L}$$

d = diameter of rope,
r = distance from center of pulley to center of rope,
P = radius of sheave pin,
$2L$ = arc of contact of rope on sheave,
δ = coefficient of journal friction, taken as 0.08,
C = empirical constant.

The efficiency of a moving pulley for forward motion or lifting is $\frac{1+K}{2K}$; for reverse motion or becket pull it is $\frac{2K}{1+K}$.

The value of C was taken as 1.8, based on the tests of the efficiency of hoisting tackle at the Pencoyd Plant of the American Bridge Co., and published by S. P. Mitchell, M. Am. Soc. C. E., in the Transactions of the American Society of Civil Engineers in December, 1903. This basis for calculations gave results accurate enough for the purpose, and no adjustment of counterweight had to be made after span was connected. Except for necessary adjustment in rear cables, the span could have been raised and lowered immediately after all connections were completed.

Nearly all material used in the temporary work was either second-hand stock material, or designed with the view of being used in other places; thus reducing the cost to be charged to this bridge almost to the item of actual cost of erection.

After the permanent draw was completed and operating, it was elevated the remaining 6 ft. 9 ins. in conjunction with the other track elevation and erection of subways.

Fig. 6 illustrates the method of taking care of the live circle during elevation and the completing of the center pier after bridge was in its final position.

The tread is composed of 18 castings, each about 5 ft. in length with lugs at the joints for jacking. These segments were designed to carry the load of bridge swinging, or the dead and live load, when supported at their ends.

The following "General Notes" which were on the working drawing taken in connection with Fig. 6 fully explain the different steps:

When bridge is elevated, jack and block up under rack 3 ins.

Jack and block up under center casting 3 ins. and tighten anchor rods.

Continue jacking and blocking under rack and center casting alternatively 3 ins. at a time until the required elevation is reached; no jacking to be going on under tread without the center casting being on firm blocking and the 1½-in. diameter anchor rods tight.

When center casting is elevated 2 ft. put in casting BC.

When bridge is elevated 3 ft. 6 ins. slide in casting TC, bolt center casting with turn bolts to TC, and connect anchor rods AR to TC. For each 1 ft. 8¼ ins. of elevation slide in casting IC and bolt to casting beneath. When center casting is at the proper elevation, bolt all of the supporting castings together and simultaneously tighten the anchor rods AR.

Blocking is to be put in so that when bridge is at the proper elevation, blocking can be removed under center portion of any section of tread.

Remove blocking under center portion of tread, build forms and construct concrete blocks as per detail of intermediate blocks M.

Not more than nine of these blocks should be under construction at the same time and these at the ninth points of the tread. When the nine blocks are completed and sufficiently set to carry the load, the ⅝-in. recess is to be tamped in with "Rust Joint" of the following composition:

1—Part Sal ammoniac
1—Part Flour of Sulphur
100—Parts Cast-Iron Borings
} by weight.

When intermediate blocks M are completed the blocking under tread joints can be removed and the space concreted leaving the ⅝-in. recess under tread as shown in detail. This recess to be filled in with "Rust Joint" as described for blocks M. The blocking is not to be removed under any two consecutive joints at the same time.

Put in anchor rods AR 1 and simultaneously adjust turn buckles, so as to give the rods considerable initial tension.

Complete pier as shown.

These instructions were practically followed in the field and the span was elevated 6 ft. 9 ins. with but very little interruption to traffic.

The design of the permanent structure, except a very general description, will be referred to only in the following special points; position and detail of counterweight, end lift on long arm only, power-driven end latch, and spring buffer to stop bridge when closing.

The bridge is double track and designed for E-50 loading, total length 196 ft. 3⅝ ins. with a clear waterway of 94 ft.; the long arm having four 29 ft. 1½ in. panels, the short arm two 29 ft. 1½ in. panels, and the panel over drum being 21 ft. 6¼ ins. This panel is provided with a light diagonal member which distributes the counterweight to make the reaction at the center posts equal and to give an equal distribution of the dead load on the rollers when swinging. An analysis of the bridge by the Williot Diagram with ends lifted and long arm loaded shows that none of the live load is carried across the center panel by this member, and we still have the condition for a partially continuous truss.

The counterweight is in the floor system of the end panel and consists of 135 cu. yds. of partially reinforced concrete, extending the full

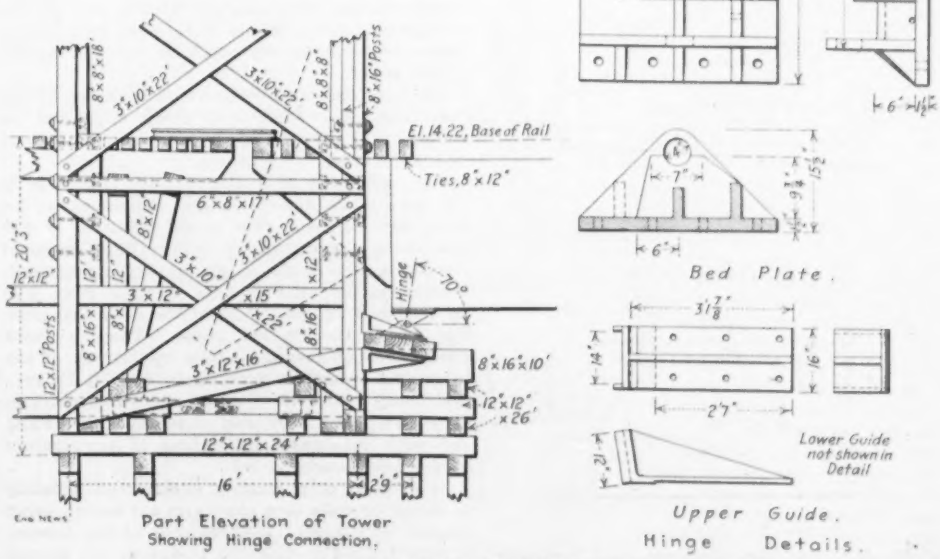


FIG. 4. DETAIL OF HINGE ON TEMPORARY LIFT BRIDGE.

width of the bridge with a facia girder on either side. This counterweight was first drawn up as one solid mass, not only carrying its own dead load to the floor beam but the live load as well, with only enough steel in line of stringers to secure the ties and deliver the shear to the beams. This was cheaper construction than what was finally adopted, but it was not considered a wise thing to put in such a large amount of concrete in one mass, as in case of possible accident and displacement of the bridge it might be very difficult to replace the bridge without removing counterweight. To remove this amount of monolithic reinforced concrete would have been a very difficult thing to do without damaging the structure, and probably causing much delay to traffic. It was decided, therefore, to use a counterweight that could be easily removed.

Fig. 7 shows a cross section and two longitudinal sections of the design adopted. It consists of longitudinal girders with small blocks between them. The longitudinal girders are reinforced sufficiently to carry a total dead load to the cross steel girders, and any live load that might come on them in case of derailment. The blocks through the center of each section of concrete are provided with a bent bar on top forming a loop projecting above the surface for lifting. When the blocks are removed the longitudinal girders can be lifted out of place. All parts of structural steel in contact with the counterweight were painted with a heavy coat of asphalt, and all joints were made true planes, the concrete being separated by two thicknesses of tar paper.

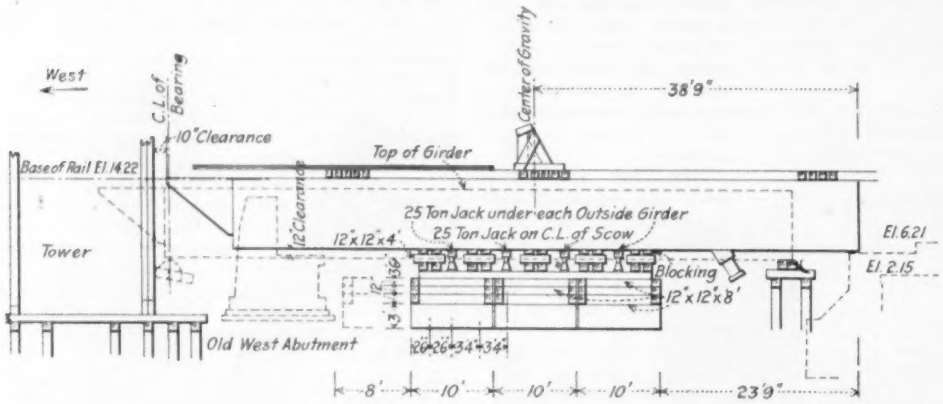


FIG. 5. METHOD OF LOADING TEMPORARY LIFT BRIDGE ON SCOW PREPARATORY TO ERECTION.

The long arm only is provided with end lifting machinery, the short arm being supported on rollers. The rollers are necessary only in case of bad adjustment of supports.

The calculated deflection of the long arm is 2¾ ins., while the calculated deflection of the short arm is zero. The large deflection is due greatly to the elongation of the light diagonal member in the center panel, previously described. Increasing the area of this member from 6.25 sq. ins. to 9 sq. ins. reduced the deflection from 3⅛ ins. to the 2¾ ins. noted. The top chord U3-U4 was shortened to take up 1⅝ ins. of the calculated deflection, making the end lift 1⅛ ins., this being sufficient to make a positive reaction at either end under any condition of loading and with reasonable differences in temperature of top and bottom chords.

On account of previously experienced difficulty in lining up rails, due mostly to the bridge being warped by different temperatures of the trusses, it was decided to line the bridge up by driving the end latch by power. It was thought to be essential that the latch be driven before th... begin to lift, as after the ends are being ... it would require much greater power to ... come the friction of sliding in addition ... flecting the bridge laterally. If the latch ... be driven from the same shaft that lift... end and the rails, this could be done ... eccentric set a little in advance of the en... rail lift. This is objectionable, however, ... limits the machinery to one direction only.

To drive the latch in advance of the ... and have the machinery reversible was a... plished by the design of the double com... cam arrangement shown in Fig. 9. The ... shows the machinery in position when en... lifted. The groove in the upper half of the ... wheel is a half circle while that in the bo... half is elliptical. When the ends are down ... the machinery is started in either direction, ... latch will be driven in the first quarter rev... tion of the shaft, and the end lifting acc... plished entirely within the second quarter re... lution, during which time the rollers working in the groove of the cam wheel are within the ... cular part and the latch remains stationary.

The vertical latch and the location of the latch casting beneath the floor beam may seem objectionable, as the application of the lateral force, when the wedge-shape latch is driven, causes a twisting moment on the end of the bridge which would tend to leave the rails out of line. However, since this twisting tends to deflect the trusses in vertical planes, one upward the other downward, which offers great resistance, and since it is entirely counteracted when the lifting cams are both on their supports, the objection is of little consequence.

The power driven latch is placed naturally on the long arm. As this requires the drop latch to stop span when closing to be on the short arm, only about 14 ft. distant from the center of gravity of 270 tons of counterweight, some sort of spring buffer had to be used to overcome the momentum of the revolving mass without doing damage to the structure.

The first requisite of this buffer is, however, that the latch be on solid metal and not on the spring before the latch on long arm can be driven. Fig. 8 shows the design of this buffer and latch. The latch for the first 3 ins. of drop strikes the spring seat, and after the span is brought to a standstill, the latch drops so that the lugs bolted on the sides engage the latch stops, and the end is held rigidly in position while the power latch is being driven.

The springs are 8 ins. long when free and each composed of three coils 1⁹/₁₆, ⅞, and ⅝ ins. in diameter, having a maximum capacity of 28,000 lbs. and a difference of 2¼ ins. between the closed and adjusted position shown in sketch. Each set of springs is backed up by the structural steel bars, which are connected by the 1¼ in. bolts and thus both sets are brought into play when stopping the span, swinging in either direction. The maximum travel of the latch ...

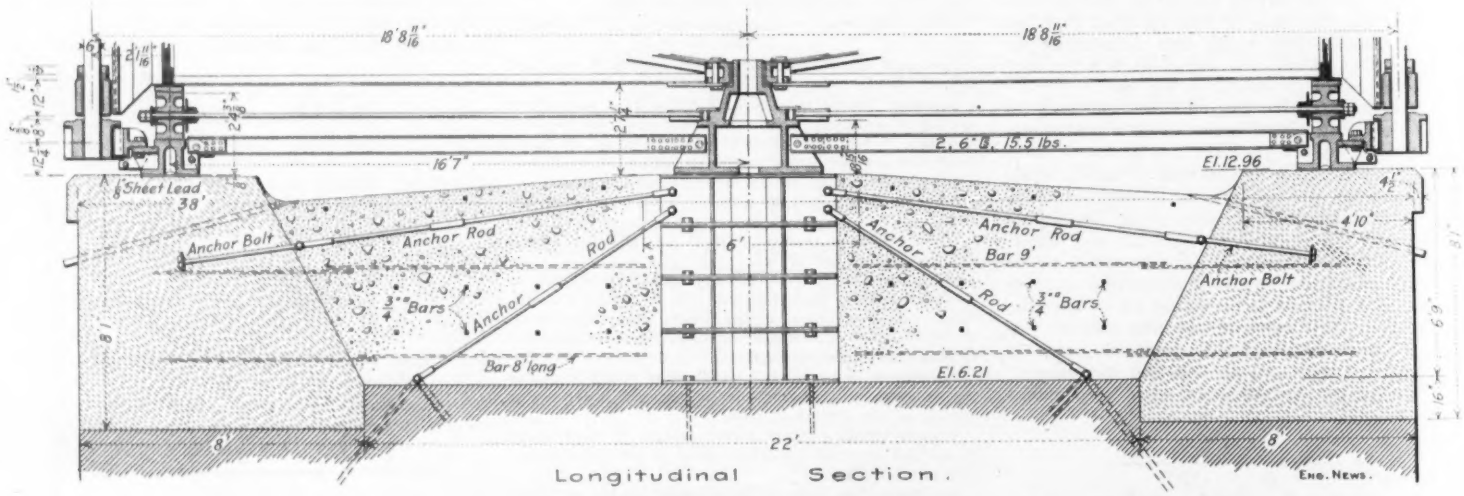
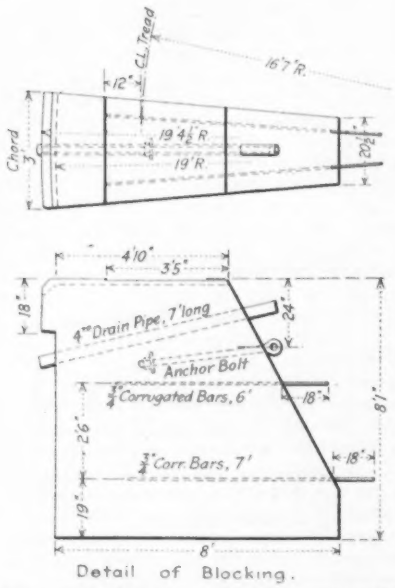


FIG. 6. CENTER PIER AND LIVE RING OF THE PERMANENT DRAW SPAN.



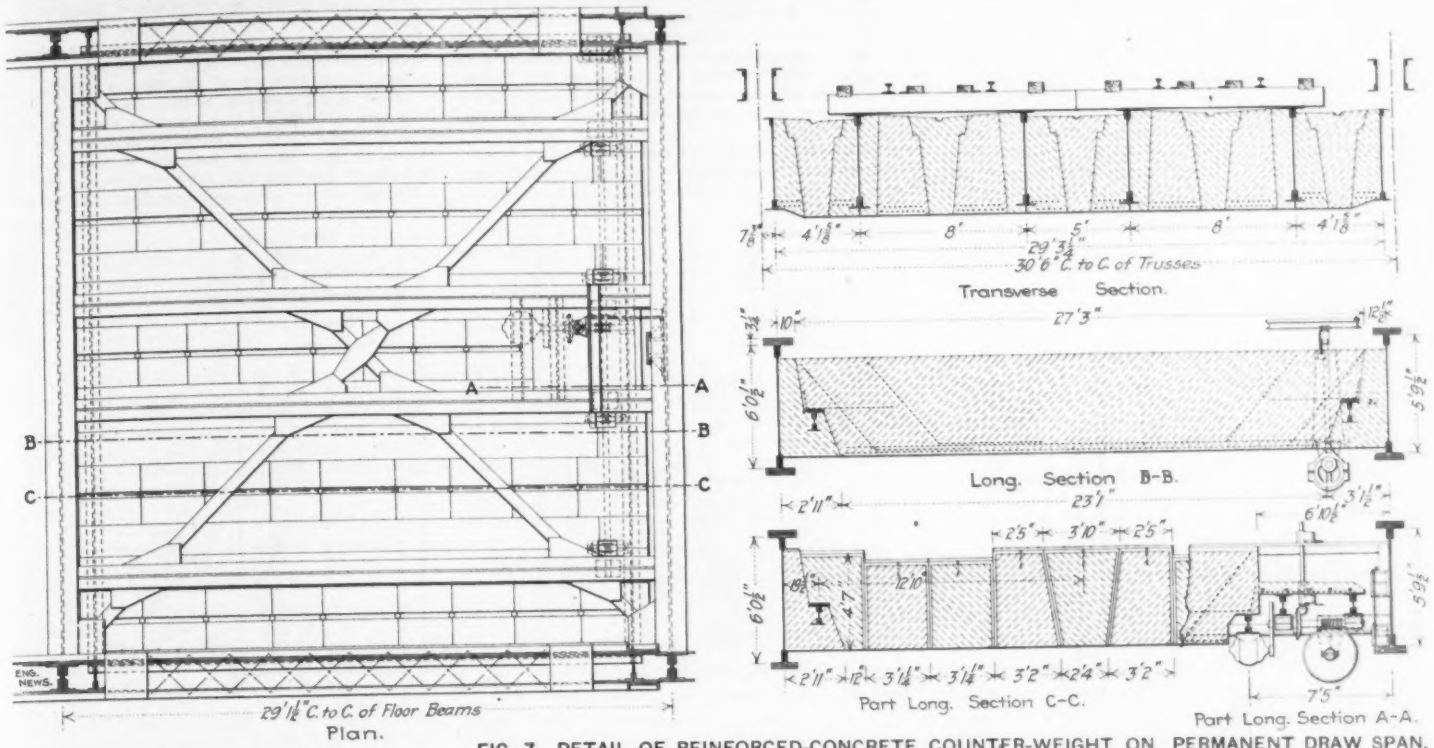
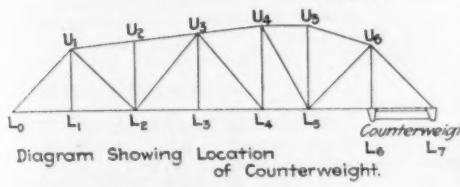


FIG. 7. DETAIL OF REINFORCED-CONCRETE COUNTER-WEIGHT ON PERMANENT DRAW SPAN.



the springs is, therefore, twice the travel of one set of springs, or 4½ ins. This will take care of the momentum of the bridge revolving at a speed of 4 ins. per second at the short end. The latch drops by gravity and is beveled for this speed. With careless handling at a greater speed the beveled part of the latch will strike the spring seat and bounce out.

This work was designed by the writer, then Designing Engineer in the Bridge and Building Department of the Chicago, Milwaukee & St. Paul Ry., with Mr. J. H. Prior, Assistant Engineer, in charge of the office. The field work was under the direction of Mr. F. E. King, Assistant Engineer.

Wheel Arrangements of Passenger Locomotives, with Particular Reference to an Austrian Innovation.

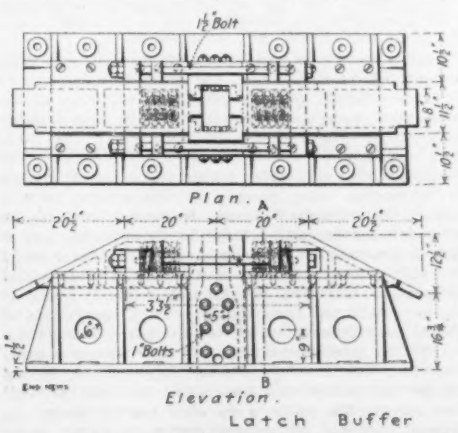
In the design of modern heavy passenger locomotives the wheel arrangement to be adopted and the distribution of the load upon the wheels are important preliminary considerations. With the increasing weight and power of locomotives on European railways this feature of wheel arrangement and distribution of weight gives a specially troublesome problem to the designer, in view of the fact that axle loads are frequently limited by government regulations. For high speeds on lines with heavy grades, six driving wheels are necessary, and engines of the 4-6-2 class have been introduced very extensively in Europe, as in this country. With the enormous fireboxes now being used, however, there comes a very heavy load on the single trailing axle, and in some cases this is very close to the allowable limit. Even in this country it has been proposed to use a four-wheel trailing truck to carry this load, but such an arrangement has not yet been adopted here, although it has been adopted to some extent in Germany and other countries. An engine of the 4-6-4 arrangement, however, may have an undesirably long wheelbase and a comparatively light load on the leading truck. On the other hand, a two-wheel leading truck for high-speed engines is not generally approved in this country, for although some railways use it, the four-wheel truck is usually considered to be safer and to give a more easy riding engine. Single leading axles (carried either in the main frames or in truck frames) are more common in Europe, although for modern high-speed engines the four-wheel truck is very generally used.

In the design of new fast passenger locomotives for the Austrian State Railways, Mr. Golsdorf, the eminent engineer, has reversed the usual order of things and introduced an engine of the 2-6-4 class, with a single leading axle carried in a truck frame of special design which is considered to make the truck as safe and efficient as a four-wheel truck. The four-wheel rear truck, under the firebox, is pivoted at its forward end, close behind the rear driving axle. The front driving wheels are as close to the cylinders as possible (the middle pair being the main drivers) and the leading wheels are placed close in front of the cylinders. In this way the wheelbase is kept within reasonable length.

Another feature of Mr. Golsdorf's design is the equal distribution of load. The maximum limit allowed by the Austrian government is 15 tons per axle, and in this engine the limit is approached in every case, the load ranging only from 13 to 14 2-3 tons, so that the weight may be taken as almost uniformly distributed over the wheelbase. In American practice, much higher axle loads are common, and as a rule there is a considerable difference between the loads on the truck axles and those on the driving axles. Thus with 20 to 26 tons per driving axle, there may be from 11½ to 14 tons per truck axle. This difference is shown by the figures in the accompanying table. It may be noted, that the Austrian engine is a four-cylinder compound with cylinders 15.6 and 26.4 ins. diameter, and 28.8 ins. stroke. The driving wheels are 6.5 ft. diameter, while the driving wheelbase is 14.56 ft. and the total wheelbase is 34.27 ft.

Locomotives.*	Load per axle, tons—Leading.	Driving.	Trailing.
C. & A.	(2) 11½	(3) 24½	(1) 25
C., B. & Q.	(2) 13¾	(3) 23½	(1) 18½
N. Y., N. H. & H.	(2) 11½	(3) 24	(1) 20½
Northern Pacific	(2) 13¾	(3) 26	(1) 15
West. (France)	(2) 12	(3) 20	(1) 16¼
Aust. State	(1) 14	(3) 14⅔	(2) 13

*All are of the 4:6:2 class with the exception of the Austrian engine, which is of the 2:6:4 class.



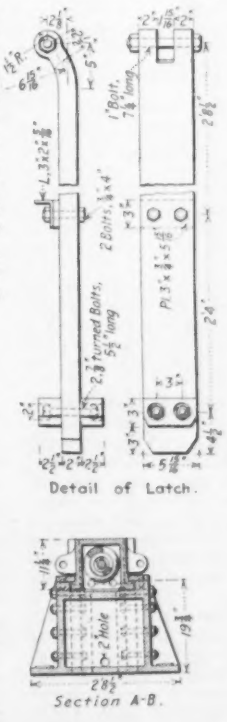


FIG. 8. DETAIL OF BUFFER SPRINGS AND LATCH.

WATER FILTRATION AS APPLIED TO TEXTILE INDUSTRIES.—Twenty years ago few textile mills in the United States made any attempt to filter their water supply. To-day there is hardly a bleachery or dyehouse in the country that has not installed some kind of an apparatus for the filtration of its water or at least is not seriously considering such an installation. The plans for all new factories include a filter. There are two very good reasons for this remarkable change in attitude toward filtration. The first is that every manufacturer has to get the best results from the material employed and he cannot afford to turn out a good article that does not appear as well as an inferior one. The second reason is the gradual pollution of the streams of the country by sewage and industrial waste, and although appeals to the boards of health and the various courts have been made time and time again the fact remains that our streams are growing very rapidly worse.—From an address by Churchill Hungerford, of Philadelphia, before the National Association of Cotton Manufacturers.

The Acid Waters of Western Pennsylvania.*

By E. C. TRAX.†

The presence of a free mineral acid in river water, especially at times of relatively low acidity, has been questioned by some chemists. The determination of the actual amount, involving as it does a complete mineral analysis of the water, is scarcely practicable for routine examinations where time is limited. Inasmuch as waters which react to methyl orange are corrosive in their action on metals, the term "free acid," used in the course of this paper shall be understood to mean acidity to methyl orange as H_2SO_4.

The principal source of this pollution is mine drainage and waste water from the coal mines and coal washers. There is a considerable amount of iron pyrites in connection with the coal veins, and the action of air and water exerts an oxidizing influence on the pyrites, the result of which is the formation of ferrous sulphate and sulphuric acid in the water. The oxidizing action continues, the iron passing through different states until some is precipitated as hydrate, this being the well-known cause of the brownish-yellow coating on the beds of streams containing this so-called sulphur water.

It is believed that the trade wastes from the various mills connected with the iron industry, while they may at times add slightly to this condition, are almost a negligible quantity. This is indicated by a number of tests of the water in the rivers above and below the mills.

Of the three large rivers in Western Pennsylvania—the Allegheny, the Monongahela and the Youghiogheny—the Allegheny is least polluted by mine drainage. While some of the smaller streams emptying into this river, notably Kiskiminetas Creek, are highly acid, they are neutralized by the large dilution with alkaline water. Only once in the records available is free acid shown to have been present. The activity in the mining industry along the river is increasing, however, and unless steps are taken to prevent it, the excessive pollution of this stream appears inevitable.

The Monongahela comes next in point of lesser pollution. Above McKeesport, where it is joined by the Youghiogheny, it is ordinarily an alkaline stream. Only occasionally in time of low stage of water has free acid been found. Below McKeesport it is acid a considerable part of the time, depending upon whether the alkaline water of the upper Monongahela or the acid water of the Youghiogheny predominates. The acidity at Pittsburg may be slightly increased by the inflow of several small highly acid streams, and drainage from the immense mills lining the shores between McKeesport and Pittsburg.

The Youghiogheny River, by far the most acid stream of any size of which there is record, rises in the mountains of western Maryland, and flows in a general northwesterly direction through the noted coke region of Western Pennsylvania, joining the Monongahela River at McKeesport. Less than thirty years ago it was a clear mountain stream, alive with fish and an excellent source of potable water. The activity in the mining and coke industries in the Connellsville region has so changed the character of the water that Samuel James Lewis states, in Water Supply and Irrigation Paper 161, U. S. Geological Survey, published in 1906:

> It is evident that the city of McKeesport is supplied with a water that is dangerous, and in no sense potable or fit for consumption by human beings.

During the winter and spring, or at any time when considerable rain is falling, the water is comparatively soft, often turbid, and sometimes alkaline; while on the other hand, when the river is low and the mine drainage consequently less diluted with fresh water, the hardness and acidity rise to enormous proportions. The transition from alkaline to highly acid water is marked by interesting color changes in the river. After a freshet the turbidity quickly disappears, and as the mine drainage becomes a factor in the flow, the iron is largely precipitated as hydrate, giving to the river a brownish-yellow color. The next change is to a mottled appearance. Greenish streaks and splotches begin to appear, due to the dissolving of some of the hydrate of iron or the slow mingling of the increasingly acid waters. Finally the river assumes a clear bluish green appearance from the dissolved ferrous sulphate. A further change has occasionally been noted in times of very high acidity: The water in the river appears black. An abnormal amount of organic matter is found to be present at such times, and the blackish appearance is thought to be caused by the action of the acid [illegible] substance.

Determinations of organic nitrogen have s[illegible] as much as 1.4 parts per million to have been pre[illegible]

Since the installation of the water purificati[illegible]nt at McKeesport complete records have been [illegible] of daily and often hourly chemical tests and daily [illegible]rio-ological examinations of the water of this river. [illegible] a record of the acidity of the water a few mile[illegible]ve McKeesport has been kept for a number of year[illegible]an industrial concern. The yearly average is as fol[illegible]

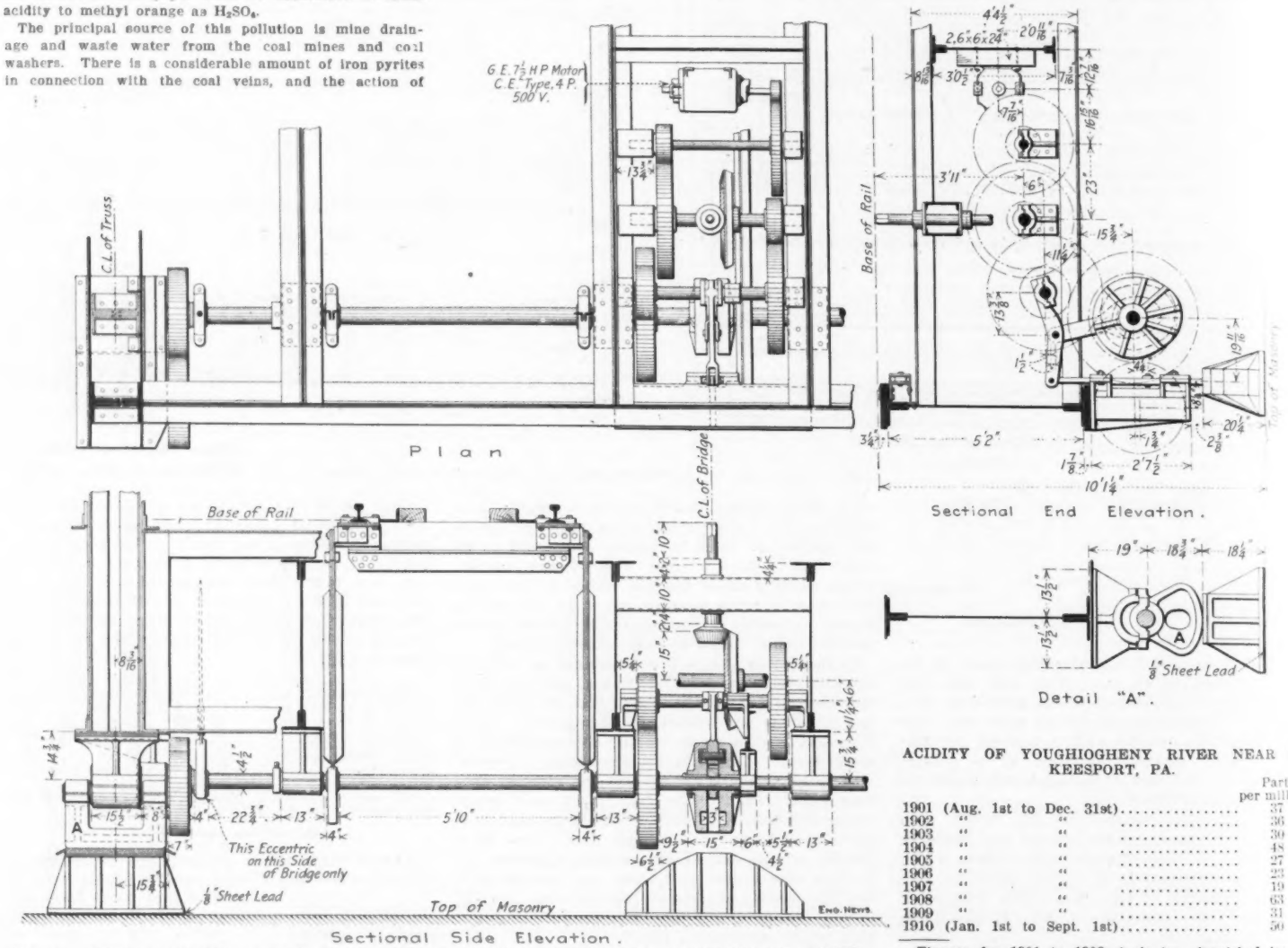


FIG. 9. DETAILS OF END LIFTING AND LATCH DRIVING MACHINERY, KINNICKINNIC RIVER BRIDGE.

ACIDITY OF YOUGHIOGHENY RIVER NEAR McKEESPORT, PA.

	Parts per million.
1901 (Aug. 1st to Dec. 31st)	37
1902 " "	36
1903 " "	30
1904 " "	48
1905 " "	27
1906 " "	23
1907 " "	19
1908 " "	63
1909 " "	31
1910 (Jan. 1st to Sept. 1st)	50

Figures for 1901 to 1908, inclusive, furnished by the National Tube Co.

The average free acid as H_2SO_4 from Sept. 1, 1906, to Sept. 1, 1907, as given in Water Supply Paper 236 of the U. S. Geological Survey, was 22 parts per million. From Oct. 1 to Dec. 1, 1908, the average was 140 parts per million. This abnormally large amount was caused by the long-continued dry weather during the autumn of this year. During 1909 the water was alkaline on 35 days, neutral on 45 days, and acid the remainder of the time, 285 days. From Jan. 1 to Sept. 1, 1910, it was alkaline 12 days, neutral five days, and acid 227 days.

The variations in the condition of the water are wide and sudden. On one occasion the acidity increased from 50 to 210 parts per million within three hours. Periods of several weeks' duration when the acidity has averaged over 200 parts have occurred twice in the last two years, and it frequently goes up to 100 parts or more for a few days. On Sept. 2, 1910, the acidity reached 270 parts per million for a short time, this being the highest recorded.

The action of this water on pumps and plumbing fixtures was graphically illustrated in the city of McKeesport just previous to the time the water-softening plant was put in operation. It became almost impossible to supply the city with water at this time, and the loss above ordinary leakage and chargeable to the acid condition, amounted to about 50% of the water pumped. The centrifugal pumps used at the present time to lift the raw water to the plant are subject to the action of the acid, and it is frequently necessary to replace parts rendered useless. Cast iron is eaten away very rapidly, and the bronze impellers are affected to some extent.

The acid and iron salts influence very widely the bacterial life, making the bacterial content of the river

*A paper read before the Central States Water Works Association, at Indianapolis, Ind., Sept. 21, 1910; slightly condensed.

†Chemist of Filtration Plant, McKeesport, Pa.

extremely variable. When the water is alkaline or only slightly acid, the number present is very great, while during a highly acid period the vegetative forms of bacteria disappear almost entirely. This condition, unfavorable for the development, is doubtless the cause of spore formation by bacteria possessing that property. The presence of large numbers of spores is indicated by the bacterial results. The germicidal action of this mine water has been considered the one redeeming feature of the pollution, and has been urged as an advantage. It has been credited with having a greater effect in preventing water-borne diseases in the municipalities using the unpurified river water than a closer inspection warrants. Certainly very little dependence can be placed upon it as rendering the supplies safe, and it is likely to fail altogether. After a rain this germicidal action is greatly reduced by the dilution with fresh water while during a rainy season it has little or no effect.

The mortality from typhoid fever in McKeesport for ten years previous to the installation of the purification plant was equivalent to an annual rate of 92 deaths per 100,000 population. The rate for 1909, the first complete year's record since filtered water was used, was 35 deaths per 100,000. While causes other than water-supply must always be taken into consideration, it appears that much of the disease in this city was traceable to the drinking water. Some cases were traced to the drinking of water from wells. This can be charged indirectly to the river water, which was so unpalatable that the people could not drink it.

In conclusion, it can be stated that the records of the past two years indicate that the acidity of the Youghiogheny River is increasing. It was thought several years ago that the quality of the water was becoming better, but this apparently is not the case. Greater extremes of acidity are reached now than in years past. It is a recognized fact that the Monongahela and Allegheny rivers are gradually becoming affected by the mine drainage discharged into them, and this source of pollution will undoubtedly increase. On account of the greater stream flow it will probably never become as serious a problem as it is in the Youghiogheny to-day.

The Growth of Steamships.*

By SIR WILLIAM H. WHITE, K. C. B.

Three years have not elapsed since the "Lusitania" and "Mauretania" began their Transatlantic service, taking "pride of place" as the largest and swiftest steamships afloat. There is no indication, as yet, of an intention to build swifter ships for that service; but the White Star Line has two larger ships far advanced in construction by Messrs. Harland & Wolff. The Hamburg-American Co. has recently ordered a steamer which will be larger and swifter than the "Olympic" and "Titanic," and the Cunard Co. is said to be considering designs for still larger vessels.

At the annual meeting of the Cunard Co. the Chairman (Mr. A. Booth) expressed his belief "that the future of the New York trade rested not with the 10,000-ton cargo boat, but with the 40,000 or 50,000-ton vessel, combining passenger and cargo capacity"—in other words with giant vessels of the "intermediate" type.

Coming from so high and responsible an authority this expression of opinion is likely to be followed by action, and the competition for possession of the "biggest ship afloat" is obviously not ended. In such circumstances it may well be asked: Whereunto will this thing grow? How will the limit of size for mercantile steamships be determined?

	Great Eastern.	"Lusitania" and "Mauretania."	"Olympic" and "Titanic."	Hamburg-America Steamship.
Length over all	693 ft.	790 ft.	882 ft.	910 ft.
Length between perpendiculars	680 ft.	760 ft.	850 ft.	879 ft.
Breadth, extreme	83 ft.	88 ft.	92½ ft.	93 ft.
Molded depth	58 ft.	60¼ ft.	64½ ft.	64 ft.
Draft of water (laden)	34 ft.	34 ft.	34 ft.	34 ft.
Displacement at load draft	32,000 tons	39,000 tons	50,000 tons	52,000 tons
Gross tonnage	18,915 tons	32,000 tons	43,300 tons	45,000 tons
Horse-power	8,000	75,000 (shft.)	40,000 to 45,000	60,000
Sea-speed	14	25½	21	22
Type of engine	Combination of paddle-wheels & single screw	Parsons turbines, 4 shafts	Combination of twin reciprocating engine & low-pressure turbine, 3 propellers.	Turbines, 4 shafts.

In the accompanying table are set out the principal dimensions and particulars of the above-named steamers, so far as they have been made known by owners and builders; and the corresponding figures for the "Great Eastern" have been added. The uniform draft of water of 34 ft. has been assumed in this table, that being the deep-load draft at which the "Lusitania" and "Mauretania" are working.

All these great ships could, of course, be safely loaded to deeper drafts, if appropriate depths of water were available at terminal ports and at all times of tide. Experience seems to show, however, that even with the depth of 40 ft. at low water, which is available, or will soon be available, in the Ambrose Channel at New York, the load draft of 34 ft. cannot be much increased with due regard to safe working conditions. At Liverpool, although magnificent work has been done during recent years in dredging deeper channels, the latest reports indicate that the depth over the bar at low water is 32 ft., and in the channel to the landing-stage 31 ft.; consequently at or near low water ships having a draft of 34 ft. are still delayed in entering and leaving port. At Southampton the latest scheme contemplates dredging to a depth of water of 35 ft. (l. w. s. t.), and here a draft of 34 ft. is clearly the maximum which can be contemplated if the largest ships are to enter and leave at all times of tide.

For this assumed draft of 34 ft. the displacement tonnages given in the table are believed to be approximately correct. They differ from some published statements, but that difference is probably due to an assumption that the ships would be laden to greater drafts. In some instances as much as 40-ft. draft has been assumed in estimating displacement, the practical conditions of service and of depths of water at terminal ports having been ignored. It must be added that the figures given for horse-powers are necessarily only estimates, but if the speeds said to be contemplated are attained the horse-powers named will not be very different from those which will have to be developed on service.

The new vessels of the White Star and Hamburg-American Lines represent a great step in advance of the largest Transatlantic steamers of the "intermediate" type previously built. The "Adriatic," for example, which was launched about the same time as the "Mauretania," is nearly 726 ft. in length (over all), 75½ ft. broad, 58 ft. deep, 24,500 tons (gross), and is propelled by twin-screw reciprocating engines of about 15,000 HP. at an average speed of 16 to 17 knots.

The North German Lloyd's steamship "George Washington," which made her maiden voyage last year, is about equal in length to the Adriatic, is 78 ft. broad, 54 ft. deep, of 25,500 tons (gross), has engines of 20,000 HP., and has made passages at an average speed of 19 knots. At a load draft of 33 ft. her displacement is said to be about 37,000 tons, and her cargo capacity 13,000 tons.

The largest ship of the Hamburg-American Line now on service, the "Kaiserin Augusta Victoria," was built in 1905. She is nearly equal to the "Adriatic" in tonnage, about 2 ft. broader, and 30 ft. shorter. The vessel just ordered will be 30% longer than the "Kaiserin" and 80% greater in tonnage.

From the foregoing figures it will be seen that the last five years have been marked by rapid and enormous increase in the dimensions of steamships, the "biggest ship" laid down having been speedily deprived of that distinction. The contrast between existing conditions and those which formerly prevailed is remarkable. More than 40 years after the "Great Eastern" began her Transatlantic service (June 17, 1860), she remained unsurpassed in size, although the chief features of her design had been determined by Brunel in 1852-3. Commercially that ship was a failure; from the scientific and technical sides she will always remain a marvel of professional skill and courage in facing new conditions and going far beyond precedent. Until the "Cedric" of the White Star Line was built (1903) the "Great Eastern" was not surpassed. Brunel worked under great disadvantages as compared with his successors of to-day in regard to materials of construction; yet by skilful structural design and close attention to details he produced a vessel in which the weight of hull in proportion to dimensions, displacement, and carrying power compared favorably with the corresponding proportions in the largest steel-built vessels of the present day.

The last half-century has witnessed great improvements in the materials and methods of shipbuilding and in marine engineering; there is consequently no reason for supposing that further increase cannot be made in the dimensions and speeds of ships if commercial considerations should make that course desirable, and if the necessary financial provision were made for the construction of larger ships and for suitable dock accommodation at terminal ports. Shipowners and dock proprietors, not naval architects and marine engineers, will have to make the decision where and when increase of size and speed shall stop.

It has been explained above that the latest additions to the dimensions of ships have been made in vessels of the "intermediate" type, for which the speeds contemplated are considerably below the speed of the great Cunarders, and are moderate in relation to the dimensions of the ships. The engine-powers and coal consumptions are, of course, much reduced in consequence of the lower speeds accepted, and the vessels will possess much larger cargo-capacities than the "Lusitania" and "Mauretania." Opinions may differ in regard to the probability of this great cargo capacity being fully utilized for most of the voyages made each year, and it is understood that existing ships of the intermediate type rarely find cargoes, even when coming eastwards, which bring them down to their deep-load lines.

Lord Pirrie has publicly stated that the first cost of the "Olympic" will be approximately one-and-a-half million pounds sterling, and those competent to form an opinion on the subject do not regard that estimate as extravagant when the size, passenger accommodation, and engine power of the ship are taken into account.

Further increase in the size of steamships would undoubtedly be accompanied by economy in the cost of over-sea transport of cargoes. Brunel understood and clearly stated this law nearly 60 years ago, and it is of universal application when ships are under way at sea. On the other hand, if increase in size and cargo capacity should be associated with longer periods in port, made necessary by the collection, shipment, and discharge of larger cargoes, or if, as a rule, full cargoes could not be secured for these very large ships, the consequent diminution of earning power, together with the increased first cost of the ships, the larger allowances for depreciation and interest on capital, and the lessened proportionate service at sea might outweigh any economies in cost of transport obtained by increased dimensions. In this way it is possible that a limit may be put to increase in size. Moreover, the great expenditure involved in the provision of suitable accommodation for very large ships in docks and harbors is already felt by the proprietors and authorities. Large expenditure has been faced at London, Liverpool, Southampton, New York, and other ports in deepening and widening channels, constructing floating and dry docks, and providing generally for ships of the largest size; but it is possible that on this side also commercial considerations may prevail, and the rapid progress in dimensions of the last few years be checked simply because it is found that, on the whole, it does not pay.

Increase in dimensions of ships is, as a rule, accompanied by greater steadiness, better behavior, and more uniform maintenance of speed in stormy weather. Speaking broadly, it may be asserted that a point has already been reached where the dimensions of ships in proportion to the lengths and heights of the largest waves are such as to secure the power of maintaining practically uniform performance, and of securing steadiness and good behavior in all weathers and conditions of the sea.

Consequently, from the point of view of behavior and the maintenance of uniform speed, no further considerable increase in size in Transatlantic steamships seems to be necessary.

No doubt it is possible to provide more varied, extensive, and luxurious accommodation in larger ships, and some slight improvement in average behavior may accompany increase in dimensions. Many passengers even now prefer to cross in slower but very comfortable intermediate steamships of large size and moderate engine power; their preference is likely to continue and may ensure satisfactory employment for the larger vessels now building or for still larger vessels. On the other hand, high speed and quick passages will always be sought for by many, if not most, persons to whom time is important. With turbine propulsion it is possible to prevent any sensible vibration and to avoid discomforts such as are inevitably experienced in swift steamers driven by reciprocating engines. Every one who has taken passage in the "Lusitania" or "Mauretania" since their screw propellers have been changed will confirm this statement, and there can be no question as to the possibility of securing equally satisfactory conditions even if still faster and larger vessels should be required.

In view of what has happened in the past, it is not possible to predict what will happen in future, but it seems certain that commercial considerations will predominate.

*Condensed from an article in the London "Times" Engineering Supplement, Aug. 31.

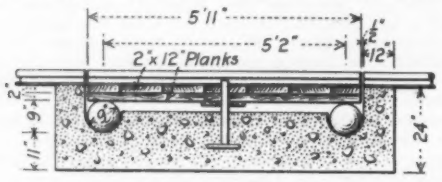
A SMOKE PREVENTER, known as the "Torpedo" apparatus, is described in London "Iron and Coal Trades Review" of Sept. 2. This device is a hollow conical structure of special perforated fire-brick blocks supported in the combustion chamber just back of the bridge wall and in the direct track of the gases from the grate. Air is admitted from a pipe passing through the ash pit. The firebrick blocks become red hot and the heated air readily combines with the unburned carbon and hydrocarbons. The makers are the Yorkshire Boiler Co., Ltd., of Leeds.

A Cannon-Ball Turntable Bearing With Concrete Ball Race.

By G. C. SCHERER.*

One of the contractors on a large job in Pensacola Harbor, Fla., having urgent need of a small turntable for a narrow gage road, improvised a perfectly satisfactory table in the following manner.

At a nearby point were a great number of old cannon balls, relics of the Civil War, which were in a perfect state of preservation. Selecting 21 of them, of 9-in. diameter, he had them carefully cleaned and greased, then prepared a heavy block of Portland cement concrete 8 ft. square by 2 ft. in thickness. In the upper surface of this block was made a circular channel of sufficient depth and circumference to accommodate



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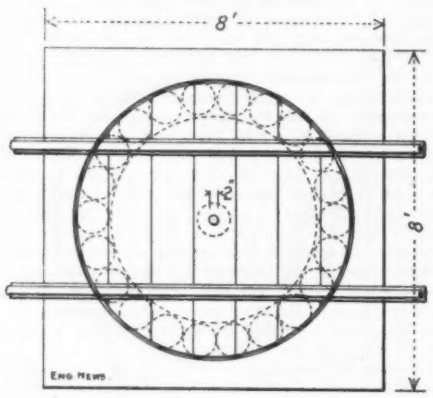

Plan.

Contractors' Improvised Narrow-Gage Turntable With a Cannon-Ball Bearing.

21 balls, as shown in the accompanying illustration.

The table, made of a double thickness of 2-in. plank and faced on its under side with ⅛-in. sheet iron, was allowed to rest on the cannon balls. The pivot which passed through the center of the table and through the entire block of concrete was made of 2-in. round iron.

Small holes, not shown in the drawing, were drilled through from the bottom of the channel, in order to let out rain water, and the turntable was completed.

Disposing of Wet Clay Excavation on the Chagres Section of the Panama Canal.†

Excavation in the Chagres section of the Central Division is almost entirely confined to earth, and much of the material is clay. Wasting material on a clay dump is expensive during the wet season, because under pressure it slides from under the tracks. Throwing the tracks is also difficult. Three plans have been adopted to dispose of the spoil economically, and all are possible because of the proximity of the excavation to the Chagres River, which carries the clay down stream.

At Gorgona, a high trestle has been built on the bank of the river back of the shops and the spoil is dumped from this trestle along the edge of the stream. Water drawn from the river is turned on it through hose and the clay is thus sluiced into the stream or wetted sufficiently to make it move slowly into the current from its own weight. The pumps for this dump have been run by compressed air, but an old French locomotive has been installed and steam will be used henceforth. The pump discharges through a 6-in. main laid along the bank beneath the trestle, from which at regular intervals there are branches to which the sluicing hose may be attached.

At San Pablo and Juan Grande, the method of wetting the clay so that it will slide out into the stream is used. The dumping trestles are built at points where the current in the river is especially strong, so that the clay, when it strikes the stream, is carried rapidly away.

At East Mamei, a low trestle has been built out into the stream, and the plan of cleaning the spoil away from this trestle by sluicing is being tried. This is in the experimental stage and it is not believed it will be so economical as the two plans outlined above, unless the portable sluicing plant can be used at several dumps. The portable sluicing plant is erected on two standard flat cars, and is shifted from place to place by a locomotive which also furnishes steam to run the pumps. On one car are mounted two pumps 14 × 10 × 8 ins. and a boom by which the suction pipe is let into the river. These pumps are old stock and, being of the reciprocating type, cannot handle muddy water so advantageously as centrifugal pumps. From the pumps the water is forced through a pipe to a second car on which the sluicing monitors are mounted. A 3-in. nozzle directed over the end of the car can throw a stream directly down and on either side. A 2½-in. nozzle carried over each side by a flexible hose can throw a stream in any direction, even so as to wash out under the car itself. A third 2½-in. nozzle is used to wash out the dump cars.

*Chief Clerk, U. S. Engineer Office, Montgomery, Ala.
†From the "Canal Record," Sept. 21, 1910.

Ownership of Harbors and Waterway Terminals in the United States.*

By HERBERT KNOX SMITH.†

The terminal is the weakest link in the water system, widely nullifying the advantages of cheap water carriage. Our waterways are important, not as a set of static conditions, but as a dynamic transportation system. Channels alone do not give transportation; they should have adequate terminals, properly controlled, in harbors effectively organized.

Our harbor organization, as a rule, is faulty. A harbor has two prime features, "commercial" and "industrial." The commercial function deals chiefly with "through" freight, with the transshipment between rail and water lines (or between water lines) of freight not destined to or originating at the harbor itself. The industrial function, on the other hand, deals with local freight. It affords rail-water connection and wharf storage for local industries and distributing houses. It affects local interests far more deeply than the mere passage of through traffic. The commercial use of our water front often interferes seriously with its industrial use. Great railroad terminals, largely used for through freight, extend along our most active frontage, crowding out its use by the local industries. In general, good harbor organization would place the through-freight terminals at relatively outlying parts of the harbor, leaving the central portion more free for local business. Many harbors could do this with much local benefit, especially the important Lake ports, with their inner (river) harbors, and their outer lake frontage protected by breakwaters—an almost ideal conformation.

In addition to harbor organization, there are four prime factors in a good water terminal: (1) Adequate wharves; (2) warehouse space; (3) transshipping machinery; and (4) belt-line railway connection between general water traffic, the adjacent railroads, and, if possible, the local industries. (The depth of water is a matter of channels, not terminals.) Furthermore, these vital factors should not be under adverse or exclusive private control, especially the belt railway, which should be the public servant of the whole port.

The supply of wharves generally is somewhere near adequate. Water-front warehouse space is inadequate, except at a few important ports. Modern transshipping machinery, except for bulk freight, is almost entirely lacking. Only 7 ports have anything approaching a general belt railroad, with a total main track of but 29 miles, serving directly only about 50 wharves.

Private interests control nearly all of our active water frontage. Public control exists in considerable degree only at New Orleans, San Francisco, Baltimore, and New York, and is greatly modified at New York by exclusive private leases for long terms. Out of 50 of our foremost ports, only 2, New Orleans and San Francisco, have practically complete public ownership and control of their active water frontage; 8 have a small degree of control, and 40 none at all. Out of 37 ports for which data are available (excluding New Orleans and San Francisco), only 14 have any publicly owned wharves (about 260 such wharves in all, many privately controlled under long leases). Out of 25 ports with available data (excluding New Orleans and San Francisco), only 10 have wharves "open" to general traffic, with a total of only 49 such wharves, the majority insignificant and antiquated. Out of 46 such ports (excluding the same two cities), a majority of the active frontage is privately owned in 40, and in 6 a small amount is so owned. Out of the 50 foremost p[orts] above mentioned, there are 21 in which railroad own[ership] and occupancy covers over 50% of the active fro[nt] and 12 more between 25 and 50%. It is our theory [that] the waterways are public highways. In fact their [essen]tial terminals are largely under private control.

Two ports only, New Orleans and San Fran[cisco] are noteworthy for their high degree of public o[wner]ship, control, efficiency, and equipment. At New [Or]leans the active water front is admirably equipped [and] controlled by a state board; most of the wharves a[nd] sheds are open for general traffic, and a municip[al] board operates 10 miles of belt-line railway giving c[oor]dination between the waterway, local industries, an[d] trunk-line railroads. At San Francisco there is an e[x]cellent system of wharves under state control, kept o[pen] for general traffic. The water terminal situation i[n] these two cities is by far the best in the country.

At many large Lake ports much of the lake fr[ont] is protected by government breakwaters, but almost [no] terminal use is made of it, in spite of the serious co[n]gestion of the inner harbors. At 4 of the most im[por]tant Lake ports there is a total front of about 12 miles pro-tected by breakwaters. On this entire 12 miles there are only about 10 active wharves, nearly all under railroad control. Of this frontage, railroads own about 7 miles, other private parties about 3, and the cities about 2. The striking lack of terminal use of such protected front seems to be due largely to adverse control, mainly by railroads, also in part to the established growth of the cities on the inner river harbors, and to litigation of titles.

There is a surprising lack of coordination between rail lines and water lines for general water traffic. We constantly see close physical proximity of rail and water lines with no commercial interconnection (except at the through terminals of the railroads themselves), and with a consequent high transfer cost. Often, indeed, rail lines are a positive obstacle to the handling of water traffic, instead of a benefit.

Terminal charges are a considerable factor in water traffic, especially "dockage," a charge on the vessel, and "wharfage," a charge on the freight passing over the wharf. Particularly on the Mississippi system, excessive landing charges have hindered traffic.

Such high landing charges, together with the absence of adequate terminals, show forcibly the extreme lack of cooperation between the localities and the Federal Government. The Government's enormous expenditures on channels are in many cases largely neutralized by the action or nonaction of the local authorities on terminals. There has been, indeed, some excellent local cooperation in channel work, as at Portland, Ore., Seattle, Cleveland and Buffalo, but the far greater need is for local cooperation in terminals. Localities should, as a rule, be required to furnish and keep open adequate terminals as a condition precedent to channel improvement by the Federal Government. It is their fair share of the work, and they alone can do it effectively.

There are thus five salient facts: First, that terminals are as important as channels; second, that our harbors have not fully developed their terminal frontage, nor are they properly organized or controlled; third, that railroads largely control water terminals, often to the disadvantage of general water traffic; fourth, that there is almost no linking up of the rail and general water systems at the water's edge, but rather the opposite tendency; fifth, that there is little cooperation by localities with the Federal Government which improves their channels.

Probably the greatest single deterrent to water-terminal advance is the present adverse attitude of rail lines toward independent water traffic, in their exclusive control of frontage, in refusal or neglect to coordinate with general water traffic, and in refusal to prorate generally with water lines in through movement of traffic. Until this underlying relation of rail to water systems is adjusted on some common-sense basis of harmony, there is little hope of great advance in water-terminal conditions.

*Letter of transmittal to the President of the United States of Part III. (Water Terminals) of the "Report on Transportation by Water in the United States."
†U. S. Commissioner of Corporations, Washington, D.C.

THE SIX-MILE SUMMIT TUNNEL of the Denver, Northwestern & Pacific Ry. is again being considered with a view to its construction. The proposed elevation is 9,190 ft. above sea level, while the present line across the range attains a summit elevation of 11,660 ft. at Corona. This summit is reached by grades as steep as 4% but the tunnel line would have grades not exceeding 0.7%. The tunnel will be about 50 miles west of Denver. The railway is intended as a direct line between Denver (5,170 ft. elevation) and Salt Lake City (4,224 ft.), having a length of about 500 miles, as compared with 630 miles by the Union Pacific Ry. and 740 miles by the Denver & Rio Grande Ry. It is already completed to Steamboat Springs (214 miles) and has crossed the heaviest part of the mountain work, except that the summit tunnel is proposed to improve the operating conditions for heavy traffic. The railway is projected by Mr. D. Moffat, who is President of the company. It was described at some length in our issue of March 9, 1905.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
BOSTON: 43 Tremont Street
WASHINGTON, D. C.: Home Life Building
SAN FRANCISCO: Monadnock Building
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In building tunnels through cities the direct route is not always the best, especially when they are at such depth as to possibly interfere with present or future building foundations. This has been proved by the city of Chicago in an expensive manner. When some of the water-supply tunnels were built they were run in a straight line between certain points, crossing diagonally under city blocks. Possibly at the time of their construction pile foundations or deep foundations of buildings were not foreseen, but at any rate in at least one case a tunnel was broken into by the piles driven for a building foundation. This case is described elsewhere, and the result was that the city had to pay for costly repair and reconstruction work on the building, and had also to build a new tunnel, which was located under the streets to avoid similar trouble in the future. In another case, when the capacity of an old tunnel (crossing under the blocks) was found too small for modern requirements, the new tunnel was built under the streets (involving greater length) for the same reason as noted above.

It may seem strange that the building department permitted the construction of pile foundations in the case mentioned, but as a matter of fact this department has never been efficiently organized, and it is probable that it had no record of (and gave no thought to) the underground conditions of the site. The water department also seems to have been ignorant of the matter until the engineers in charge of the building repair work discovered the broken tunnel as the source of the trouble. The case might have been much more serious had the tunnel crossed a part of the city where high buildings are erected, and where it might have been broken by the sinking of caisson foundations. In such a case, the failure of large surrounding buildings might have resulted from the escape of water from the tunnel. The Chicago instance may serve as a warning both to builders and building departments to investigate the underground conditions of a building site before work is authorized or commenced, as a failure or collapse may involve the city or the builders in heavy financial loss. It may serve equally as a warning to those in charge of the planning of tunnels and other underground works to consider the possible future troubles from excavations (such as for deep basements) and the sinking of foundations. Incidentally, reference may be made to a case at Denver, where surface conditions necessitated the location of a viaduct column directly over a sewer. Instead of an ordinary pedestal, a large block of reinforced concrete had to be built surrounding the sewer and distributing the load on a base below the level of the sewer.

It is well established that there is small danger in laying concrete in freezing weather provided the proper precautions are taken to heat the materials before mixing and to protect the concrete after laying, so that at no time during the process do any of the ingredients drop below a freezing temperature. Concrete work under such conditions is being carried on every winter with resulting structures equally as strong as those laid up in less severe weather. At the same time numerous cases can be cited where, on account of the absence or insufficiency of protection or the ineffectiveness of the plant, winter-laid concrete has proved to be very weak, so that some engineers still feel reluctant to authorize the winter operation of concrete plants in climates where the thermometer persists below the 32° F. mark. For these engineers we would call attention to the account on another page of this issue by Mr. E. A. Forward of the concrete work on the St. Andrews dam north of Winnipeg, Man. In no piece of construction that has come to our notice has so complete a frost-proof plant been provided nor so extensive a work done in extremely low temperatures.

The plant is fully described in the article so there is no need to do more here than to call attention to its completeness and to the severity of the temperature in which it was worked. Not only were the materials heated, but the mixing plant and the forms in which the concrete was deposited were encased in tar-paper-covered framework and the interior of both provided with a heating plant which raised the temperature to an average of + 50° F. during a time when the outside temperature averaged —20° F. and sometimes dropped as low as —50° F. This would be pretty fair heating in an ordinary dwelling, much less in a temporary construction framework. With this protection, over 100 cu. yds. of good concrete was laid daily over a three months' period, at an additional cost of but $1 per cu. yd.; less than the excess cost of dewatering, had the work been prosecuted during the high water of the summer months. It is but right to note that the operations each winter were confined to a restricted area, but even considering that fact, the effectiveness with which it was carried out deserves commendation.

An automobile emitting, as it passes, a cloud of disagreeable smoke is a familiar sight to any city dweller. In New York City this nuisance has been recently prohibited by the Board of Health in an amendment to the Sanitary Code. But it appears that little if any relief has resulted. In fact, an appeal which has just been made to the health commission by a committee of the National Highways Protective Society has brought out the information that in the three months elapsed since the amendment went into force, not a single conviction, nor even an arrest has been made on the strength of it. And this in spite of the alleged fact that there has been in this city no noticeable diminution in the density and frequency of smoke from automobiles.

In the gasoline engine, which supplies the motive power of by far the majority of automobiles in present use, the emission of smoke results from the combustion of lubricating oil in the cylinder. This burning of lubricating oil is not an essential feature of the regular operation, and in fact it has a somewhat deleterious effect on the engine. It is, however, a thing not always to be easily avoided, especially in the case of a comparatively new engine, which may require more than the normal amount of lubrication until its first stiffness has been softened by wear.

There are, fortunately, mechanical considerations, such as the waste of oil and the fouling of piston rings and spark-plugs with soot, which make the prevention of smoke of direct benefit to the automobile owner. For this reason, the percentage of automobiles that emit objectionable quantities of smoke is small.

Just what relation automobile smoke has to the public health and why its regulation should be delegated to the health authorities we leave to our readers.

The water famine in Mount Vernon and other parts of Westchester Co., N. Y., raises some interesting questions. Can the water famine be excused on account of unforseeable deficiency in rainfall, or is it due to lack of storage, or to insufficient drainage areas? If the blame rests upon lack of foresight or preparedness on the part of man rather than upon some vagary of nature who should be held responsible? We cannot answer these questions to a certainty, but it looks as though the water famine is in part due to the efforts of several water companies to secure control of the water-supply of a rapidly growing suburban area joining and near New York City without making sufficient provision for the future. Perhaps the conditions which have arisen are partly due to the failure of municipalities and companies to agree on franchise or contract terms which the companies deemed essential before entering upon important extensions. It may be that there is not water enough available in very dry years to supply the Westchester Co. cities and towns without going so far afield as to encroach upon the drainage areas already appropropriated by New York City. This suggests that it may yet be necessary for New York City to help out these towns continuously, just as it is now doing temporarily, by permitting connections with the Croton supply. In fact, legislation has been proposed, if not already enacted, looking to the permanent supply in bulk of some Westchester sections by New York City. Obviously, such a solution of the problem would be facilitated by municipal ownership throughout the county.

It is commonly said that the United States uses the English system of weights and measures. As a matter of fact the United States has greatly improved on the English system by dispensing with a great number of the ancient units, that served no useful purpose except to furnish a stock argument for the metric system advocates.

It is not generally realized in the United States to what extent the old units are still retained in use in Great Britain. It is pretty well known that the U. S. gallon differs slightly from the imperial gallon; but the following from the London "Times" of Sept. 10, indicates that other gallons still persist in England.

At a recent meeting of the Central Association of Dairy Farmers recommendations were agreed upon as to the London prices for Michaelmas contracts for the supply of milk. The prices were as follows: For short-distance railway transit milk 10d. and 8d. per imperial gallon, and for long-distance railway transit milk 9½d. and 7½d. per imperial gallon. These prices represent respectively 1s. 9d. and 1s. 5d. and 1s. 8d. and 1s. 4d. per barn gallon.

From the above it would appear that the "barn gallon" is a trifle more than double the imperial gallon. The only conjecture possible is that the "barn gallon" of milk must be a peck measure full. When one sees the archaic system of milk distribution and sale from metal cans in dusty streets, still prevalent in England and for that matter on the continent, one is almost ready to believe that the "barn gallon" may be dipped out with a peck measure.

In measures of weight, while, in the United States all units except the pound and ton have become obsolete*, and the short ton of 2,000 lbs. has driven out the "long" ton of 2,240 lbs., except in the coal and ore trade, the English still cling to the "hundred weight" which is not a hundred pounds but 1/20 of a "long" ton, which is

*We except, of course, the drug and jewelry trades.

the only ton in England, so far as we are aware, and also to the "quarter" and "stone." Penny-in-the-slot weighing machines in England always show a person's weight in "stones."

Market customs are even more confusing to the uninitiated than the varying weight units. The following are the units in which current quotations are made of principal products on the London market: Barley, per 400 lbs.; Maize, per 480 lbs.; Oats, English, per 312 lbs.; Oats, Russian, per 304 lbs.; Rice, per cwt. Wheat, English, per 480 lbs.; Manitoba, per 496 lbs.; October in Liverpool, per 100 lbs.; September in Chicago, per bushel. Hay, per load. Linseed, California, per 410 lbs.; La Plata, per 416 lbs.

The same paper containing the above quotations advertises many parcels of land for sale with the area given in acres, roods and perches. We may also note that the furlong still survives in the English race courses.

The Usurpation of Engineering Functions by a Public-Service Commission.

There has been a great amount of needless delay in preparing for the second rapid-transit subway in New York City—the Lexington Avenue Subway, of which we gave a general account in our issue of March 10, 1910. Now occurs an event that may complicate the situation and cause further delay. The Chief Engineer of the Public Service Commission, Mr. Henry B. Seaman, M. Am. Soc. C. E., under whose direction the detail plans were developed, has resigned, apparently because of serious friction between himself and some of the Commissioners. The plans are complete; indeed they have been complete for a year past in sufficiently definite fashion to permit of calling bids and awarding contracts on a month's notice. If in selecting a new Chief Engineer the Commission goes outside its present engineering staff and brings in a strong, able man to whom all the problems are new it can hardly be expected that he will be satisfied to proceed without thorough review of the plans and such modification as may be necessary to bring them into accord with his individual views of proper construction. If he refrains from any changes at the present moment, it is more than likely that the equivalent of such changes will be made later on; and in either case the final result is further delay.

Any other outcome would indeed be unnatural. A Chief Engineer cannot conscientiously assume full and detailed responsibility upon another's plans, and is bound to insist on changes, in so far as the work has not gone beyond possibility of change. If he does assume responsibility without fitting the plans to his individual opinions and methods, it is apt to be with a mental reservation as to various features of the design which will come to the surface subsequently in an involuntary tendency to ascribe unforeseen troubles or difficulties to the design, i. e., to the work of the man who went before.

In any event, the resignation of Mr. Seaman, just before receiving bids for an enormous, complicated and costly engineering undertaking, is very unfortunate.

Of course a change in Chief Engineers, through resignation, discharge or death, is always liable to occur during the execution of any great work, public or private. We should not comment on the incident did it not appear that for some time past the Commission has been violating principles the observance of which is of far more importance to the engineering profession than strained relations between any one engineer and his superior administrative officers. We go so far as to say that even though the Commission had demanded Mr. Seaman's resignation in set terms, and with entire justification (a point on which we make no assertion of either fact or opinion), yet the attitude of the Commission towards its Chief Engineer at various times in the past seems to have been such as to call for severe criticism from both the engineering profession and the intelligent public. This can be made clear by outlining very briefly only one of several occurrences of like sort which have come to our attention.

It appears from the statements made that when the Commission had fixed the route and general features of the new subway, the elaboration of designs was left to the Engineering Department, under Mr. Seaman; not, however, with final authority. The Commission considered it necessary to review his plans, thereby expressing a distinct lack of confidence in the engineer chosen by the Commission itself. Of course, there would have been no real impropriety in having the plans reviewed by a consulting board of engineers, or even by a single competent consultant. But this is not what was done. The Commission itself undertook to review the plans, through three of its members, none of them engineers. And they went about the task in peculiar manner, not by retaining a consulting engineer as aid, but by gathering free advice from various sources, members of the Engineering Department itself, voluntary critics, and the like. The alterations evolved by the help of this inquiry were then recommended by the Commission to its Chief Engineer, and, as the latter displayed a rather natural reluctance to accept certain of them, there was trouble. The Commission's statement to the press (through one of its members) describes these facts; it is as follows:

> Months ago when the Triborough plans were approaching completion the Commission considered that because of their importance they should be most carefully studied. Commissioners Maltbie, Bassett and Eustis were appointed a committee and were aided by consulting engineers. This review of the plans was resented by Mr. Seaman, but the Commission insisted on its right to secure the fullest information possible. Acting on its judgment and on advice obtained, the committee from time to time suggested changes in the plans and it may be said that on the important ones Mr. Seaman after discussion agreed. Conditions finally, however, became such that the Commission felt it necessary to ask for the resignation of its Chief Engineer. As a matter of fact for over a month Mr. Seaman has been on leave of absence and Alfred Craven has been Acting Chief Engineer.

Diligent inquiry of both sides to this unfortunate controversy fails to reveal the employment of any consulting engineer or engineers at this juncture, in the sense long understood by the engineering profession: that is, an independent outside engineer or board of engineers charged with and paid for its responsibility of passing impartial judgment upon a controverted engineering question.

This may be a good way to get rid of a Chief Engineer, but it is a poor way to arrive at sound conclusions in engineering matters. And it seems proper to add that a more direct way of getting rid of an engineer would have been far better, in case a change was felt to be necessary.

We should like to be shown that we are wrong in our understanding of the facts, and that the records of the Commission prove that instead of going to Mr. Seaman's engineering subordinates or to engineers employed in one department or another of the city, on whom no great measure of responsibility for gratuitous opinion can be laid, the Commission really based its changes in engineering design upon the recommendations of a board of eminent advisory engineers, duly selected and paid for that purpose.

We record these facts and opinions with regret. We are strong believers in public-service commissions. We appreciate the enormous burden of complex problems resting on the New York Commission, problems not only of the design and construction of vast additional transportation facilities for New York City, but also of regulation and control of existing transportation and lighting companies. We wish the Commission unbounded success in carrying on its manifold duties. We do not question its devotedness to the public interests, as it sees those interests, but we do think that it has usurped engineering functions and has violated professional principles to such an extent as to call for a strong protest from engineers. Nor should the protest stop with engineers. It should be joined in by all who are interested in the solution of transit problems in New York City and all who believe in the necessity for strong, competent public-service commissions.

Will It Pay to Build Still Larger Steamships?

The competition among shipping lines for the Transatlantic speed record, which has existed since the very beginning of steam navigation and was active, indeed, in the days of sailing packets, seems to have ended, for the present at least, with the monster Cunard greyhounds. In its place has arisen a competition in size of steamers.

This competition is discussed in the present issue by Sir William White, the designer of the "Lusitania," and "Mauretania," who is admirable to speak authoritatively on this subject as any one in the world. Sir William sums up the matter by saying that the ship designers and shipbuilders can build bigger vessels and whether they will be constructed turns on the commercial question: "Will it pay?" It is clear that it will not pay if the time necessary to load and unload these huge ships much exceeds the port delays of vessels of ordinary size. Nor will it pay unless sufficient cargo is available to utilize in some fair degree the enormous capacity of the vessels. Sir William intimates that even now the largest vessels plying between New York and European ports rarely find enough cargo to load them to their designed draft, even on their eastbound voyages.

The probability is that the steamship companies building these latest monsters of 40,000 tons and upward are looking rather to the advertising value of the vessels and to the prospect of attracting the best paying class of travellers by adding still further to the list of available luxuries on shipboard, rather than to any economy in freight transportation.

The point of greatest importance to the civil engineer, however, is that these record-breaking monsters are not representative of ocean traffic generally. They are so abnormal that they should be wholly left out of account by engineers in planning such works as channel entrances, piers and docks. Sir William White plainly shows that the limiting draft for steamers plying between New York and the chief British ports is fixed by the depth at the latter. We commend this fact to the Atlantic coast cities who are demanding that Congress shall give them as deep a harbor entrance as New York. Comparison shows that our Atlantic ports already compare favorably in depth of water with the best ports of Europe and are far superior to the ports of other continents.

It is, perhaps, not generally realized that the ten or twenty huge vessels which have been built during the past dozen years and which have so raised the record of length, beam and tonnage in the world's merchant marine, all ply between the port of New York and Europe. No other shipping route in the world has sufficient freight and passenger traffic to make the building and operation of such huge vessels financially profitable.

It may be of interest to see what the tonnage is of the vessels on some of the best known lines operating on other main ocean routes. The famous Peninsular & Oriental line, in the list of sailings from London for September and October to Egypt, India, China, Japan and Australia, shows eight steamers of 6,000 to 8,000 tons and four of 10,000 to 14,000 tons. The British India Co., plying also from London to the Orient and Australia, shows for September and October 16 vessels of which five are of 6,500 tons, seven are between 5,000 and 6,000 tons, and four under 5,000. The French Messageries Maratimes steamers sailing from Marseilles to African and Asiatic ports, in September, includes five vessels of sizes from 3,716 tons to 6,385 tons. The North German Lloyd sends to China in September one vessel of 8,800 tons and one of 10,900 tons, and to Australia two 8,000-ton vessels, and one of 11,570 tons. The Pacific line from Liverpool to South American ports in September and October sends four vessels of 5,000 tons or less, two of 8,000 tons and one of 11,500 tons. The Orient line to Australia has one vessel of 9,000 tons, and three of 12,000 tons in its list of sailings.

It should be understood that all the above figures are taken from the current advertisements of the several companies. They do not, of

course, show the entire fleets of these companies; but they are certainly a fair showing of the average size of vessels in ocean passenger service on the principal maritime routes other than that between Europe and the United States.

It is true that most of the new vessels built are of the large sizes, but it is probably safe to say that 10,000 to 12,000 tons is about the limit of profitable size on all the trade routes of the world other than the transatlantic passage, between Europe and North America. Even here it is the enormous passenger traffic and the prices obtainable for luxurious accommodation that has brought about the building of vessels of 15,000 tons to 25,000 tons and now to above 40,000 tons.

The question to be solved is whether the public will pay the price. It is well known that the first cost of the vessels per ton rapidly increases when the size rises above, say, 10,000 tons. So far as steadiness in a seaway is concerned, Sir William shows that the vessels now in commission of 20,000 tons or thereabouts are so satisfactory in respect to steadiness that there is practically little to be gained in increasing the size. In economy of operation also, there is little reason to suppose that the 40,000-ton vessel has any practical advantage over the 20,000 ton. In fact there seems little disposition to increase the size of vessels built solely for freight carrying above 10,000 to 12,000 tons as a maximum.

We have thought it worth while to draw attention to the above facts because the public generally wholly misunderstand this subject and because in the present popular craze over waterway improvement, nothing seems too absurd to serve as an excuse for raiding the United States treasury. We shall be surprised if the size of these three or four monstrosities in naval architecture is not brought forward shortly as a clinching argument why the Government should pour forth untold millions on a dozen different harbors.

LETTERS TO THE EDITOR.

Ancient Engineering Works in Ceylon and Other Far Eastern Countries.

Sir: I have read with interest the article in your issue of Sept. 22 on the "Ancient Irrigation and Water-Supply Tanks or Reservoirs of Ceylon." I have had the privilege of knowing the Island of Ceylon well and have gone over a good portion of it on horseback and am somewhat familiar with the material part of your correspondent's most interesting article.

Many of our engineers of the present day would no doubt be suprised at the great undertakings started centuries ago in the Far East, and at the magnitude of works there only failing through the decadence of nations which built them.

Ceylon is a good place for the traveler interested in such works, and to my mind more interesting than the ruins of Yucatan. There is plenty of good accommodations and traveling is easy and comfortable. The hotels and rest houses are good, the government railroads and highways excellent, and Colombo, the port of call, is right on the ocean thoroughfare to the Orient.

Truly, Geo. Harper.

Youngstown, Ohio, Sept. 26, 1910.

Why Water Filtration Has Been Recommended by the Health Officer of Cleveland, O.

Sir: In response to your inquiry regarding the possible pollution of the water-supply of Cleveland and the need for purification, allow me to give a short extract from my recent report on the subject:

> Since April, 1904, Cleveland receives its drinking water from an intake crib which is placed in Lake Erie four miles from shore. As this distance was not considered sufficient to insure against shore pollution at all times, the water was examined daily by the bacteriological laboratory to obtain the true facts in the case.
>
> In 1905—the colon bacillus was found on 12 days.
> 1906— " " " " " " 11 "
> 1907— " " " " " " 29 "
> 1908— " " " " " " 40 "
> 1909— " " " " " " 43 "
>
> Up to Sept. 1 of this year it was isolated on 38 days. On the first of last March we had a thaw. On the following four days the colon bacillus was present in the drinking water. On March 6 we again had a thaw and during the following four days the colon bacillus was again isolated. At the same time, the oil which commonly floats on the Cuyahoga River could be detected in the drinking water, and during the month of April 102 cases of typhoid fever were reported to the health office. This fact shows that pollution does reach our intake crib from time to time, especially after a thaw or severe rain storm, and the number of days on which this contamination takes place increases from year to year.

I think this justifies my conclusion that the improvement of our drinking water must be taken into serious consideration right now, and in my judgment the safest way to bring this about is filtration.

Very respectfully yours,
Martin Friedrich, M. D.,
Health Officer.

Cleveland, Ohio, Sept. 26, 1910.

[A lengthy illustrated description of the Cleveland water-works tunnel and intake crib was published in our issue of Aug. 11, 1898. The tunnel is 26,000 ft. in length. The crib is in 49 ft. of water, but the two inlets are 12 and 24 ft., respectively, from the surface of Lake Erie. —Ed.]

Sewage Disposal at Leicester, England, and Recent Advances in Sewage Purification.

Sir: The interesting article in your issue of Sept. 22, on "Sewage Disposal under Difficulties at Leicester, England," adds further testimony to confirm several of the recent advances in the art of sewage purification.

(1) The fact that septic action retards rather than facilitates "purification both in beds and upon land."

(2) The fact that gases arising from the sludge in septic tanks "throw up large quantities of solids" which flow off into the oxidizing beds, and therefore further reduce the desired oxidation process, and moreover tend to clog the beds.

(3) The fact that the slow passage of a thin sheet of sewage over a surface of what might be practically called clay land (by broad irrigation), effects a "wonderful" improvement, somewhat similar to the passage over the surfaces of the stones in a coarse-grained filter, whether this improvement is caused by simple physical means or by micro-organisms.

In other words, there is being more and more recognized, on the one hand, the disadvantage of treating foul instead of fresh sewage, and the further disadvantage of passing sewage through septic tanks; and, on the other hand, the advantage of passing thin layers of fairly fresh sewage over extensive surfaces, exposed to simple attracting forces which segregate the suspended matter, as well as to an abundance of air facilitating bio-dynamic activity.

The analysis of the sewage, as given in the paper, further suggests, as it appears to me, an insufficient appreciation of the character of the purification process. We are given but one figure for the suspended and but one for the dissolved matter contained in the sewage, without any discrimination between mineral and organic matter. It is clear that the organic matter alone calls for a purification and the figures convey no idea of the amount, except indirectly and imperfectly through the ammonias and the oxygen absorbed. The large figure for matters in solution, given as 112.6, might be chiefly mineral for all we know, and need no purification. And, as the figure has a decimal attached, there is even a semblance of great accuracy, while for the present purpose the whole figure has little practical value. The analyses would have much practical value if not only the organic matter were separately given, both suspended and dissolved, but if also the suspended organic matter were further divided arbitrarily into at least two parts; one part being that which breaks down under the ordinary conditions, within the time required to deliver and to make the sewage inoffensive, say perhaps 24 hours, and the other part being that which resists decomposition for a much longer period. The difference between these two classes of organic matter so materially affects the methods of their best treatment, one being generally an oxidation and the other often a reduction process, that more instead of less knowledge concerning their relative amounts would be of decided practical value, and I do not know that they are anywhere given.

Very truly yours,
Rudolph Hering.

170 Broadway, New York City, Sept. 24, 1910.

The Physical Meaning of Entropy.

Sir: The gist of the article upon "The Physical Meaning of Entropy" by Mr. A. L. Menzin, in your issue of Sept. 1, lies in his italicized paragraph giving his conclusion as to the physical definition of entropy:

> In the conversion of heat into work, whether of heat external to a working substance or contained within it as intrinsic energy, entropy is the minimum avoidable waste per degree of the absolute temperature at which all of this waste may be rejected by the working substance.

In this connection the following points are to be noted. (1) This definition makes entropy synonymous with heat; for it defines entropy as the "waste" of a Carnot cycle, and the waste of a Carnot cycle is its exhaust-heat. Such a definition is as lucid, and as nearly true, as any that confuses dividend with quotient, or mass with energy. We all know that entropy is something akin to heat. The one thing we all need to know is wherein heat and entropy are distinct and different. (2) This definition treats the Carnot cycle as if it were a single, simple process, whereas it is a complex combination of four distinct ones. (3) It speaks of the "waste" involved in "the conversion of heat into work." Yet the keynote of thermodynamic action is that in the conversion of heat into work there is no waste, and can be none. If waste occurs the process is not one of conversion, but of transfer. (4) It assumes that heat extrinsic to a working-substance may perform work therein.

The above positions taken by Mr. Menzin are sheer misstatements of physical fact. But there are also omissions of essentials, in that:

(1) The definition omits all cognizance of the fact that change of entropy is always an attribute, or accompaniment, of only one process, viz.: thermal conduction, or its synonym, impact and friction.

(2) It omits all cognizance of the fact that work-performance affects only temperature, and never entropy; wherefore our physical grasp of entropy must be based upon our physical grasp of the only thing (in the more familiar science of mechanics) which is also unaffected by work-performance, viz.: Mass.

This contribution of Mr. Menzin's is offered with its author's statement that:

> From a simple equation based on the efficiency of a Carnot cycle the writer arrived at the definition stated. It may be of interest to note that this definition harmonizes with two somewhat different definitions previously advanced—one attributed to Clausius and another by Mr. James Swinburne.

But the sole task undertaken by Mr. Swinburne when President of the Institute, and persevered in since, has been to recall errant modern pedagogs to the strict definition of entropy originally "attributed" to Clausius. Therefore there can be no distinction between Swinburne and Clausius. Nor can I find any difference between Mr. Menzin's definition and the statements prevalent among thermodynamic writers. Mathematically speaking, they are all true. It is true that, in the particular case of isothermal heat-transfer, or conduction, the change in entropy is proportional to the energy-transfer per degree of local temperature. But this is only half the story, and the least significant half. It does not tell us what entropy is, nor how it acts, but only how it is altered. And in the case where the entropy does not alter, but remains working vigorously and unchangingly for our good, as in every steam-cylinder in the land, there occurs no heat-transfer, or "waste." Hence Mr. Menzin's definition then becomes inapplicable and meaningless.

The above criticism the writer knows (or hopes) is largely destructive. Those desirous of more constructive work along these lines are referred to the writer's recent book "Energy."* They will find therein several things:

(1) Entropy defined, not in terms of a whole Carnot cycle (which is a combination of four processes each difficult to understand), with the working-substance a "perfect gas" (which has never been known to exist), nor as a purely mathematical function involving quantities (such as dQ) not previously defined, but they will find it defined as a feature of every simple thermal process, with existing and familiar solids, liquids and gases as the embodiment.

(2) That entropy is not a process at all, but a state of matter; the degree of subdivision of its mass. Entropy is as distinct and different from any process whatever, such as a "rate of waste," as force is distinct from power, or temperature from heat.

(3) Entropy defined mathematically, not merely in terms of heat, which is itself a term which has never yet been defined and whose several meanings serve by no means interchangeably in the famous Clausius equation, but in terms of familiar mechanical mass and of its subdivision—the first things comprehended in childhood, the first things given exact concepts in the study of elementary mechanics. This mathematical definition is:

$$\text{Entropy} = \Sigma\, MM.$$

The factor MM is a part of every correct equation for mechanical energy. It is a part of the definition of weight—placed there by Newton, in 1685 or thereabouts. It should be a part of our everyday concept of weight, force, position and energy. If it is not, and if its thermal counterpart entropy therefore remains obscure, the blame should lie upon those who teach mechanics, a science supposed to be founded upon Newton's work.

(4) The inspectors of the book "Energy" will find entropy there illustrated scientifically in terms of chemical and electrical, as well as mechanical, parallels. They will find it defined also in terms of the still more familiar relationships of the playground, the college and the shop. For social entropy is one of the most familiar features of modern life, albeit its identity with thermal entropy has not yet been pointed out as clearly as it might. Mr. H. L. Gantt, Mr. Harrington Emerson and Mr. C. U. Carpenter are doing a lot of publishing about, and helping somebody make a lot of money out of, industrial entropy. It would hurt neither them nor the

[*Reviewed in Engineering News, Feb. 17, 1910; author's criticism of the review on March 17, 1910.—Ed.]

heat-engine designers if they both realized that they were talking about one and the same thing.

To the reader who desires more of a mental picture than can be given by the above, yet who has not this book at hand, it may be said, briefly, that entropy is a quality of mass closely akin to weight. It was Prof. Zeuner who first gave it the name *heat-weight*. He observed the close parallel between the performance of work by water-weight in falling down hill and that by entropy falling down temperature.

But entropy is not exactly the internal weight of the heat-mass. Weight, according to Newton, is a characteristic of mass under three conditions, viz.: (1) The mass must be subdivided; the weight then exists between the two portions, not in either one of them; no single mass-portion can possess weight; (2) the distance of separation between the mass-portions affects the weight; (3) tangential motion between the mass-portions affects the weight.

Thus, it is commonly said that a flatiron "possesses" weight, and a determinable, unchanging weight. But the statement is fundamentally wrong, and no student who knows no better can ever understand entropy. A flatiron at the center of the earth, for instance, manifests no weight. Far above the surface of the earth it would manifest virtually none. At the surface of the moon, or the sun, or Mars, etc., it would have a different weight from that at the surface of the earth. The weight is as much a function of location as it is of mass, and as much a property of one mass as the other.

Obviously, the flatiron does not truly "possess" any of these weights. It is only a partner in a joint concern. The weight perceptible here among men belongs as much to the earth as it does to the flatiron. The weight near Mars is as indicative of the mass of Mars as it is of the mass of the flatiron.

In addition to the stock of earth-weight the flatiron is simultaneously a partner in as many such different weights as there are heavenly bodies in the world.

We cannot measure here all of even its earth-weight, except at the poles; for the earth is turning around. A spring-scales at the equator can reveal only about 99.6% of the true weight. Centrifugal force destroys the rest. If the earth's day were only about 90 minutes long, the flatiron would weigh nothing at all at the equator.

Newton stated these facts in the equation

$$\text{Weight} = C\,\frac{M_1 M_2}{S^2}$$

Wherein C is a coefficient, M_1 and M_2 are the two mass-portions between which the weight is embodied, and S is their distance of separation. Tangential motion between the two is precluded.

In any group of mass-particles, such as a solar system or hot body, the total internal "weight" must be the summation of this function for every possible pairing of the particles into systems of two. The aggregate of such mass-pairing would be mathematically stated as ΣMM.

The factor ΣMM enters every correct expression for mechanical force or energy whatever, whether potential or kinetic. That is to say, neither force nor energy can ever be regarded as a quality of mass. It is a feature always of mass-pairing. This fact must be remembered, whenever either thermal, chemical, electrical or social (as well as mechanical) force or energy are considered as functions of mass. After the principles of conservation of mass and space, this universal subdivision and pairing of mass in forceful and energetic mutual reaction is the broadest and most basic of all physical facts.

Without a thorough grasp of this factor no energetic phenomenon can be understood in its mechanical aspect. Yet in most engineering courses in mechanics it is never mentioned.

In the case of thermal force and energy this factor has been called *entropy*. It is only an unnecessary narrowing of our vision, however, to restrict the term thus. It applies equally to all the energetic sciences.

Entropy acts as weight does, always in one direction, down. But since the aggregate "weight" embodied between the molecular heat-particles alters with every change in their relative position and tangential velocity, we cannot snap-shot it quickly enough to get a definite perception of it, as we have plenty of time to do with the flatiron-earth weight. Therefore we have to phrase our mathematical definition of entropy in terms of its effects, calling it $\frac{dQ}{T}$ when transfer (or "waste," as Mr. Menzin puts it) occurs, or defining it in terms of dT by Clapeyron's equation when no transfer is present. But its physical nature is no more mysterious or mathematical or vague than is the separateness between flatiron and earth whereby they embody between them weight, which they must lose when they become one or when they separate too remotely.

To the engineer whose collegiate study of mechanics cannot recall to him this function ΣMM, and especially the general facts which it expresses mathematically, these explanations will naturally be unintelligible. But to him who has been taught true mechanics the physical reality and nature of entropy can have no mystery.

Yours very truly,

Sidney A. Reeve.

20 Central Ave., Tompkinsville, S. I., New York City, Sept. 23, 1910.

Conservation and New Nationalism.

Sir: I feel that it is perhaps a waste of time for any western man, regardless of his knowledge of conditions or his desire to be unprejudiced, to attempt to discuss "conservation" or "new nationalism." When my first letter on the former subject was prepared, I hoped that in response to my request some persons who know what "conservation" really is, would arise from some obscure place and tell us about it. I can assure you that I have been disappointed because of the silence that has prevailed. We of the West are still in darkness. Both of these "isms" are popular subjects for discussion. Both seem unpopular when pertinent questions are asked concerning them.

There are some other questions that myself and many of my friends would like to have discussed and answered, if possible. One of these is prompted by your remarks regarding my letter of the 15th of August. You say that the public domain is a national heritage. I believe this is true. The public domain has always been a national heritage. Because it is a national heritage it should not be locked up for the benefit of unborn generations. The public domain has always been open for the stronger sons of the East. It is their opportunity. Shall it be preserved as their opportunity or shall we turn it over to some bureau at Washington in order that the home-seeker and developer may be kept out and a revenue created for the national treasury? Are we fundamentally a nation of trees, coal veins and flowing streams, or does citizenship really count for more? All that the West asks, in so far as my knowledge goes, is that the remaining public resources be administered by the general government until some good citizen of the country appears on the ground and desires to put them to a higher use; that is, to support a home.

If these resources can be made to support homes, has the national government any reason for holding them for any other purpose? When, in the history of the United States, should the policy of the nation have changed in this matter? Columbus discovered a country that had probably been "conserved" for the white race. Now a part of the white race desires to restrict settlement so that another kind of control can develop under government supervision. What would have been the result had the thirteen original States decided, through their representatives in Congress, that the remaining public domain was a national heritage? That it should remain perpetually under national control and those who used any part thereof should pay for the privilege? Was it an error to put the homestead law in operation? Was it a crime to build up the civilization of the Mississippi Valley? Because every person cannot own a dam site is it an error to permit those who have the ability to develop power from the flowing water to do so? We can see no reason for such a policy as long as a burdensome monopoly does not develop. We would like to have some person who is wholly unbiased make a study of conditions as they are here on the ground, not as they are painted in the popular magazines. We would like to have them study what the states are doing. We should like to have them inform themselves thoroughly. If after that they would hold that anything like "new nationalism" is necessary or even advisable, we would admit that our case is serious.

There is too much government to-day, both national and state. Unless one has had personal contact with our national machinery at Washington he is ignorant of the government under which he lives. Western states do not have the wealth which would enable them to support such a government as has New York or Massachusetts. I presume that there are many departments in both states which could be wiped out of existence and no one aside from the office-holder and a few friends would ever know that a change had been made. The same condition prevails at Washington, only in a much more exaggerated form. How many men in Congress know where the money goes that is spent each year?

One word in closing. You compare the relations between the state and the national government with those that might exist between the state and the civil divisions of the state. The states would have trouble with counties, for instance, if they attempted to impose upon the counties. If the state owned the resources which must be utilized to support people, the state would be condemned by the counties if it should hold that these resources are for the benefit of posterity and the state treasury. To make your comparison mean anything you must imagine that the state has a great army of employees who must be supported and all state property must be maintained in the name of the state in order to support this army. You will find that the relations between states and counties are defined by laws that are fair to both. There is no reason for ill-feeling, because the people of the state all have the same p[illegible]—to develop every resource and to make homes for [illegible] who desire to come from the East, if you like.

It is useless for me to say anything rega[illegible] the former administration of forest reserves. N[illegible]rson seems to be an authority or to be able to jud[illegible]ters of this kind unless he accepts what the forme[illegible]ester has said of himself as being final and conclusi[illegible] If a close acquaintance with forests here in the W[illegible] helps a man's judgment, then western men should h[illegible]e to anticipate that a portion of their views should h[illegible] some weight. If five years in the government s[illegible]e at Washington would not aid one in studying an[illegible] the federal bureaus at the national capitol, then t[illegible] whom would you look for judgment as to the effective[illegible]ss of these departments? Personally, I wish no a[illegible]ority over any more resources. I have no private reason for favoring local control of resources. I go further than to say that the state should control them. I say and I shall always say, that every resource that will support a home should go to those who have the ability to carve a livelihood out of a wilderness. The nation has always stood for such a policy. The states which contain natural resources to-day will always support such a policy. We are confident that there will always be a sound majority in the country which will demand that the home be placed above any later creations of man, even though such creations may develop under national authority. You misunderstand me if you think that I hope for any other policy than one which will place resources in the hands of the people who can use them. I am not in favor of reserves or preserves of any kind or description if, to maintain them, prevents settlement. This policy will be carried into practice, I am confident.

Sincerely yours,

Clarence T. Johnston, M. Am. Soc. C. E.,
State Engineer.

Cheyenne, Wyo., Sept. 26, 1910.

[Previous letters from Mr. Johnston on this same general subject appeared in our issues of July 14, p. 51; July 28, p. 103; Sept. 22, p. 316, 1910. A reply to Mr. Johnston's letter of July 28, by Mr. G. M. Bacon, M. Am. Soc. C. E., of Salt Lake City, Utah, appeared in our issue of Aug. 11, 1910, p. 155.—Ed.]

FOUR BATTLESHIPS, 15 torpedo boat destroyers, 10 submarine torpedo boats and 2 colliers are now under construction by the U. S. Navy Department, under the direction of the Bureau of Construction and Repair.

AN INTERESTING METHOD OF WELL CONSTRUCTION was described by Mr. Martin Deacon, Assoc. M. Inst. C. E., of Westminster, England, in the course of a paper on "Water Supply" recently presented by him before the Royal Institute of Public Health. We reprint from the London "Surveyor" of Aug. 12, as follows:

In the gravel and sand beds, especially the latter, there is a great difficulty in admitting the water to the well entirely free from fine particles of sand, which will, as time elapses, very seriously reduce the capacity of the well, and cause damage to the pipes and valves of the pumps. A well in a sandy formation, such as greensand, is lined with bricks, concrete, or iron cylinders, and, until a few years ago, it was the common practice to admit the water through a small area at the bottom of the well. In 1904 the late Dr. Deacon successfully carried into practice an entirely new method of admitting the water through a large area, free from sand, having the effect of very considerably increasing the efficiency of the well.

As this is entirely new and novel I propose to describe shortly its chief features of construction and working.

This particular well is in Bedfordshire, and has a total depth of 175 ft. The first 66½ ft. through the clay is 10½ ft. diameter and is lined with brickwork, while the remaining 108½ ft. is 9½ ft. diameter, and is lined with cast-iron cylinders, of which 65 ft. is in the lower greensand, the total depth of which was estimated to be 250 ft.

The bottom cylinder terminates in an inverted cone, at the apex of which a valve is fixed. Each cylinder in the greensand is 4 ft. deep and is perforated with 60 holes in which fine straining material is fixed. A steel plug fills the small hole provided for the purpose.

On completion of sinking, the well was pumped dry, and the men were thus enabled to enter it and to examine and calk up the joints where necessary. They then proceeded to unscrew the plugs one by one. With a few exceptions, the water immediately entered through the strainers into the well, carrying with it the finer particles of sand, and at the same time gradually shifting towards the outside of the strainers the larger particles of sand. After a short time the sand ceased to flow for the following reason. There is a minimum velocity above zero at which water can travel through sand without carrying the finer particles of sand with it, and the effect of displacing with steam or water pressure the finer particles from the neighborhood of the strainer and leaving only a hemisphere of larger particles, is to increase the area through which a given quantity of water has to travel. Thus with an increased area there is a sufficient decrease in the velocity of the water within the hemisphere round the strainer to prevent the carrying of fine sand into the well. To those strainers which did not discharge water freely owing to being blocked by particles of clayey material, was applied a pipe through which steam was passed under pressure into the material outside the well, thus displacing and loosening the clayey material, which was subsequently washed through with the water into the well.

Several wells have recently been constructed in which this method has been adopted, and with most favorable results.

Irrigation Accounting—Its Essentials and Advantages.*

By N. E. WEBSTER, JR.†

That accounting can and will have an appreciable effect in securing and in even insuring the success of legitimate irrigation developments may not be apparent to those who have not fully studied the matter. Yet it is the proposition which I present to this Congress as true and worthy of acceptance, and to the demonstration of which I shall devote the time given me.

Last June I had the pleasure of being present at a dinner given by the Board of Control to the officers of the Congress. As the speeches were generally reported in the press, I am violating no confidences when I tell you that these men foresaw and feared the results of unwise irrigation enterprises. Wildcatting was the expression used and there were sober expressions of opinion that some present tendencies, if not corrected, could only result in prejudicing the mind of the general public so that it would be increasingly difficult to sell a water right under even the soundest development in all the arid country. The speakers might well have gone further and said that probably even before that time it would be almost impossible to finance an irrigation scheme by the sale of its securities. And that brings us to consider that in the final analysis, the persons most interested in the success of irrigation are those who buy and hold irrigation bonds and those who buy and use the water rights developed thereby. Bankers and constructors must both consider these interests if enterprises are to be successful.

And now what are the essentials to success in the development and construction of an irrigation project? I am talking broadly of the whole subject without regard to whether the projects are to be built by the nation, states, local districts or private enterprises under any of the forms of irrigation organization. These are important details, but they are details only. And in this connection I will say that I was for some years connected with the federal Reclamation Service, have been consulted and employed by Carey Act and private enterprises, and have a fairly representative acquaintance among those now engaged in irrigation development by means of all these forms of organization, so that what I have to say will be drawn from experiences with and directed towards the needs of all rather than any particular situation.

There is not time now to discuss the fine points of a scheme of accounts adapted to the needs of irrigation. Moreover, the system must of necessity be devised with a special reference to the conditions of each enterprise. One will require what is unnecessary to another. Townsite development, generation of power for sale, dealing in agricultural lands, merchandising, transportation, hotel keeping, etc., are frequently associated with irrigation development and when thus connected should have provided therefor accounting methods of the most modern and progressive types. But there are phases which are common to all irrigation development which should be carefully reflected in the accounts and for which standard forms of reports should be adopted in order to secure the best results.

I think we will get the most out of this study if we divide irrigation costs into those for financing, for engineering, for construction, for selling, for operation and for general expenses. Cost statements should show the totals for a given period and to date for each class. But these costs should be analyzed further to show the expense upon different classes of work and upon different physical features.

Moreover, there should be adopted uniform methods of stating the asset and liability accounts, particularly those which are peculiar to the business of irrigation. While the experience of other lines of industry will help in deciding such questions, there are some which must be studied probably for the first time. One such problem is that of the proper treatment of the right to the control of certain water-supplies obtained by appropriation from the states, and which it is proposed to sell in the form of water rights. Should such controlled but wholly or partly undeveloped water-supplies be shown in the accounts as assets? Again, when water rights are sold before the completion of a project should the estimated construction cost of these particular water rights be deducted from the sale prices and the excess carried to the credit of the loss and gain account as profits before the actual construction cost is determined, and probably when only a small fraction of the sale price has been collected? If this is new to you, it probably sounds academic and theoretical, but upon the answer to this latter question rests the determination of whether such unliquidated and to a degree problematic profits are subject to the federal corporation tax, and when. Here, as often, theory goes ahead and points the way to practice.

*Condensed from a paper prepared for the Eighteenth National Irrigation Congress, Pueblo, Colo., Sept. 27, 1910.

†Of Niles & Niles, Certified Public Accountants, 111 Broadway, New York City; late Consulting Accountant, U. S. Reclamation Service.

You will note that I am contending for a standardization of accounts, as well as for accounting per se. There is a reason for this, and one which should appeal strongly to those who are directing irrigation enterprises. It is not an accident that railroad accounts have been reduced to a standard so that each company keeps accounts essentially similar to those kept by all other companies. It did not happen that bank statements came to be presented in the same form the country over. It was not by chance that insurance companies came to use identical methods. Nor as some may think, were these results brought about solely by the imposition of governmental control. It is true that national banks were required to report in a standard way, but the state and private banks adopted the same forms, not from necessity, but for self interest. Railroad accounts have been developed along identical lines, not because of governmental control, which is a very recent development in this matter of accounting, but because the accounting officers of the railroads have been working together, each contributing what he had found valuable and giving this to the others through the medium of their national association. Before there was any public-service corporation legislation, the accounts of gas, electric light, water and traction companies had grown to be so nearly uniform, that many companies made but little change in methods in complying with the requirements of the public utility laws when enacted.

And there was a reason for this uniformity. By it each company had the opportunity of comparing or contrasting the effectiveness of its own methods with the results obtained by others, all tending to the highest efficiency and economy. This reason should be just as potent in the irrigation industry. What are the best and cheapest forms of organization and methods of work? Who knows? Ten years ago there was probably not a single contracting organization in the country that was attempting to analyze its construction costs. When a job was completed the contractor knew how much he had gained or lost; while it was going on he guessed conditions as he had originally in bidding on the work. To-day, contractors are endeavoring to ascertain costs as the work progresses so that costly methods may be abandoned for more economical ones, and the final balance brought on the right side of the loss and gain account.

But some one says "we let all our work by contract and do no actual construction ourselves." Very well, but what of the future costs of maintenance? Are they being fixed upon a basis of accurate information or of hopeful guesses? I venture the surmise that 90% of the maintenance charges have been made upon no better basis than a sheer guess with an eye always to what the other fellow charges. Ten years of good accounting should give us a vastly better method of forecasting maintenance charges upon different classes of work and under varying conditions.

There was another reason why these older lines of industry developed similar accounts and adopted standard forms of reports. They found that thereby they could more readily market their securities when additional capital was required. A railroad or public utility which should go into the money market for a loan or to sell an issue of bonds, and which was unable or unwilling to exhibit balance sheets, statements of operating expenses and fixed charges, of gross and net earnings and gross and net income, would probably conclude that the money market was very tight. But your situation is likely to be about that unless you adopt the methods which obtain in these other lines of business. I have seen a letter from an eastern broker to an irrigation company whose securities he was attempting to place in which he asked the company's officers to stop writing in terms of glittering generalities about their scheme but to send him statements of figures, adding "Nothing else goes in this town."

Moreover, in addition to the credit required by irrigation companies upon bond issues and direct loans, they are large buyers of construction materials. Are they treating themselves fairly and intelligently in developing and conserving the commercial credit to which they are entitled? Look in the rating books of the mercantile agencies. There are no ratings for irrigation companies. This may be because they are not in trade, but I think it is probably from another cause. Within a year I was with a district manager for one of the mercantile agencies when he received from an irrigation company a reply to his request for information that he might furnish to a subscriber from whom he had an inquiry. He expressed much surprise at receiving a copy of the company's latest balance sheet with other explanatory figures. But I asked whether this was so unusual as to excite comment, for I had supposed it to be a common practice for business men to furnish statements to these agencies. He replied that my idea was correct except as to irrigation companies, but that never before had he received such a statement from one of these companies, although he had frequent inquiries as to their financial standing.

These are some of the direct advantages which irrigation enterprises may secure from a wisely planned and well conducted scheme of accounts. But I think that even this is not all. If all enterprises that know they are financially sound, conservatively managed, and prepared to give value for all they get, will unite in the adoption of standard forms of reports, it will not be so very long before the financing interests will look for and insist upon having these statements, with the result that if there are such fake or wildcat schemes as some believe, they will have to disclose the fact in their reports, or bear the burden of partial discredit because of their unwillingness to submit the statements which would set forth their condition.

In conclusion, I do not wish to leave the subject without offering a suggestion as to the method by which, in my opinion, the quickest and most effective results can be secured. I believe this Congress should favor and foster an association of those interested in irrigation accounts. Company officers as secretaries, treasurers, auditors, and bookkeepers should be urged to unite for the common interest. Bond banking houses should be invited to assist in the preparation of such statements as will be most valuable to them. Professional public accountants, I am sure, will be glad to help, bringing to the subject the experience gained in examinations of many other lines of business. Such an organization can work directly with the accounting officers of the companies themselves while the program of this Congress should always be open for the general dissemination of the views and recommendations of the association and for discussion thereupon.

I am no prophet and do not undertake to forecast the future as to the increase or lessening of state and federal control of corporations. But if it never comes to the irrigation industry, you will have gained immensely from the practical application of scientific accounting, while if it does come, in respect of accounting at least it may be a negligible incident requiring only that you make one more carbon copy of statements you have all along been issuing.

Population Within Political and Natural City Limits.*

An editorial in your issue (New York "Sun") of Sept. 24 on "The Growth of American Cities," suggests calling attention to the apparent discrepancies which sometimes occur in the population statistics, as given by the U. S. Census Bureau. These naturally confine the figures to the political boundaries of cities, and do not necessarily in all cases apply to the actual populations virtually making up a large city.

At the International Exhibition held during the last summer in Berlin, which related to the planning and collection of data—there was exhibited a large chart† collection of data—there was exhibited a large chart* prepared with reference to rapid-transit conditions in the largest cities of the world. City rapid-transit cares nothing for the artificial boundaries, but solely for the actual populations grouped around a large metropolitan business center. The statistics given upon the chart related to the year 1907. As giving a better idea of the real size of cities than the usual census figures, I append those relating to population and add the rides per annum credited to the population, including steam, electric and horse railways, omnibuses, carriages and ferries.

POPULATIONS AND RIDES IN SEVEN METROPOLITAN CENTERS IN 1907.

City.	Population in millions.	Rides in millions.	Rides per head of population.
Greater London	7.2	2,254	348
Greater New York	4.3	1,740	406
Greater Paris	3.9	1,040	268
Greater Berlin	3.2	976	304
Chicago	2.1	820	383
Philadelphia	1.5	603	412
Greater Boston	1.3	651	500

Incidentally, I may add that the exhibited chart indicated that since 1890 among the seven cities given, Greater New York has been growing fastest, then follow in order, Greater London, Greater Berlin, Chicago, Greater Boston, Greater Paris and Philadelphia.

As Greater Berlin is growing much faster than Greater Paris, it will soon be, if it is not already, larger. As Greater Boston is growing faster than Philadelphia and has already almost the same population, it will overtake it before long. The figures also show that in Greater Boston the inhabitants ride more, and in Greater Paris less, than in any other large city.

THE CONCRETE DAM of the Danville Water Co., at Danville, Ill., is being given an increase of 3 ft. in height, and four Taintor gates are being installed for the control of flood waters. A small hydraulic plant, which is used to operate low-lift pumps for the filter plant, is being improved and an additional turbine installed. The work is under the direction of Mr. H. M. Ely, Superintendent Water-Works.

*A letter to the New York "Sun," by Rudolph Hering, of Hering & Fuller, New York City.

†Die Weltstadte und der Electrische Schnellverkehr. By P. Wittig. 1909.

The Deformations of a Four-Sided Hopper.

By CLYDE T. MORRIS,* M. Am. Soc. C. E.

The necessity for stiffeners on the bottom of a hopper is generally recognized and such stiffeners are usually put on, but there seems to be little uniformity in the methods of proportioning them or in the direction in which they are run. The lack of definite knowledge as to the distribution of the stresses in such a structure and the most efficient position of the stiffeners led to the series of experiments which are here described.

A hopper 4 ft. square, without stiffeners, was built and presented to the Ohio State University for the purpose of these tests, by the Jeffrey Manufacturing Co., of Columbus, Ohio. The hopper was erected at the University in the fall of 1908. It was suspended from two wooden beams by ears, as shown in Fig. 1, at such a height above the floor that the material could be easily handled and the necessary readings taken.

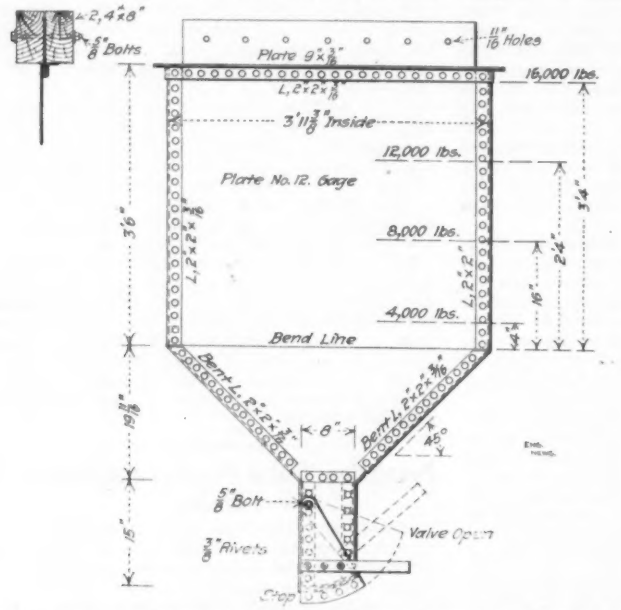

FIG. 1. DETAIL DRAWING OF FOUR-SIDED HOPPER TESTED FOR DEFORMATION AT OHIO STATE UNIVERSITY.

The experimental work was done and most of the details of the apparatus were worked out by students at the University as thesis work. Mr. R. H. Downing and Mr. W. O. Sanzenbacher of the class of 1909 made the detail drawings for the hopper, erected it and carried on the experiments during the year 1908-9. Much credit is due them for the manner in which they worked out the details of the apparatus and for the interest and ingenuity shown in the work. The results of their experiments were not altogether satisfactory because the material used in loading the hopper (crushed limestone) was not sufficiently heavy to cause deformations large enough to warrant definite conclusions. Moreover, the extensometers which were used were of the lever type, with wood connecting bars, and the results were affected very largely by changes in temperature and probably also by the jar of loading the material into the hopper. They found that, in general, the stresses were higher while the material was being withdrawn through the valve at the bottom and that there was compression near the horizontal bend line.

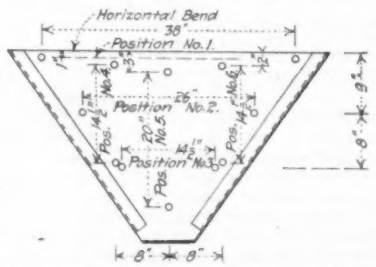

Fig. 2. Diagram Showing Positions of Micrometer Microscopes for Measuring Linear Deformations of Four-Sided Hopper.

MEASUREMENT OF LINEAR DEFORMATIONS.—The work was taken up in the fall of 1909 by Messrs. D. R. Born, Wm. H. Norton and G. S. Pierce of the class of 1910. The lever extensometers were discarded and a pair of micrometer microscopes was substituted. Spots were polished on the face of the hopper bottom, located as shown in Fig. 2, and on each of these spots was made a fine scratch to be used as a mark from which to measure with the microscopes. A steel bar was made with similar scratches (approximately) the same distance apart as those on the hopper, to be used as a comparator. This, it was thought, would eliminate the temperature error, the bar being of the same material as the hopper, and to further reduce this error the work was all done at night when the temperature variations were small. The maximum variation during any run was 4° F. Probably the temperature of the hopper varied more than this amount from the temperature of the standard bar, owing to the fact that the temperature of the material with which it was loaded would not change as rapidly as that of the unprotected bar. Readings were taken with the microscopes in each of the six positions shown in Fig. 2.

BULGE MEASUREMENTS.—To determine the bulge in the hopper three steel piano wires were stretched horizontally over the surface of the bottom, about 1 in. away from it as shown in Fig. 3, and the distances from these to the face of the bottom were measured with a micrometer gage at the points indicated. These readings gave us the bulge of the bottom due to the different loads.

DESCRIPTION OF TESTS.—The material used for loading the hopper was steel punchings, which behaves similarly to crushed stone when in a pile and has about the same angle of repose. This material weighed about 250 lbs. per cu. ft.

The hopper was loaded by shoveling the punchings from the north side, the punchings being weighed out in 250-lb. lots on a platform scale. Readings were taken for zero load, 4,000 lbs., 8,000 lbs., 12,000 lbs. and 16,000 lbs., and then as the load was being withdrawn through the valve at the bottom, for loads of 12,000 and 8,000 lbs. and for zero.

Three complete tests were made, but the results of the first two were unsatisfactory, owing to the omission of certain important precautions in handling the micrometer microscopes. The bulge readings of the micrometer gage for the first two tests agreed very well and so these readings were not taken in the third test.

RESULTS.—The linear deformations were determined from the micrometer microscope readings, but these had to be corrected for bulge. In applying these corrections the bulge was assumed to be circular and the length of the arc was calculated from the chord (measured with the microscopes) and the middle ordinate (measured with the micrometer gage).

Table I. gives the average unit linear deformations (total deformation divided by the length) for the various positions indicated in Fig. 2, in ten-millionths, and Table II. gives the bulge in inches at the points indicated in Fig. 3. The plus sign in the deformation table indicates compression or shortening and the minus sign indicates tension or elongation.

TABLE I.—UNIT LINEAR HOPPER DEFORMATIONS IN TEN-MILLIONTHS.

	Total load in hopper in pounds.					
	Loading in—				Drawing out—	
Position.*	4,000	8,000	12,000	16,000	12,000	8,000
No. 1.....	+562	+540	+776	+714	+47[illegible]	[illegible]22
No. 2.....	+143	—131	—285	—1,089	—6[illegible]	[illegible]74
No. 3.....	+103	—316	+153	—435	—4[illegible]	[illegible]88
No. 4.....	— 3	—224	+138	—486	—6[illegible]	[illegible]9
No. 5.....	—241	—348	—1,082	—265	—3[illegible]	—811
No. 6.....	—903	—111	—467	—1,222	—1,6[illegible]	—295

*Positions indicated in Fig. 2.

TABLE II.—BULGE OF HOPPER WALL, IN INCHES.

	Total load in hopper.					
	Loading in—				Drawing out—	
Position.*	4,000	8,000	12,000	16,000	12,000	8,000
A_1	—0.007	—0.002	0.000	0.006	0.001	0.001
B_1	0.002	0.006	0.011	0.014	0.003	0.013
C_1	0.006	0.010	0.013	0.019	0.000	0.017
D_1	0.005	0.007	0.010	0.011	0.010	0.014
E_1	0.004	—0.004	—0.004	0.001	0.001	—0.004
A_2	0.014	0.024	0.027	0.030	0.037	0.040
B_2	0.058	0.076	0.087	0.091	0.133	0.133
C_2	0.078	0.100	0.111	0.115	0.168	0.169
D_2	0.080	0.093	0.102	0.110	0.157	0.160
E_2	0.014	0.018	0.022	0.025	0.038	0.038
B_3	0.005	0.012	0.018	0.023	0.010	0.010
C_3	0.064	0.074	0.083	0.091	0.108	0.111
D_3	0.006	0.008	0.011	0.011	0.016	0.014

*Positions indicated in Fig. 3.

Figs. 4 to 9 show contours drawn through points of equal bulge, and Fig. 10 shows the variation in bulge at points C_1, B_2, C_2, D_2 and C_3 plotted from Table II. In Fig. 1 the height of the material in the hopper is indicated for the various loads put in. The material was leveled off before readings were taken in each case while loading in, but was allowed to assume its own surface while drawing out.

The effect of the shoveling in of the material from the north side (left hand in the figures) is seen in the shifting of the point of maximum bulge toward the right in Figs. 4 to 9 and in the greater linear deformations shown in position No. 6 than in position No. 4.

Assuming that the deformations per linear inch were uniform, for the length of each position shown in Fig. 2, and that Poisson's ratio is ¼, the horizontal and vertical unit stresses in the plate may be calculated at each of the points of intersection of these positions. The modulus of elasticity of the material was found from samples cut for test to be 29,500,000 (average of two tests). Table III. gives the stresses at the intersections of the positions shown in Fig. 2, calculated on the above assumptions.

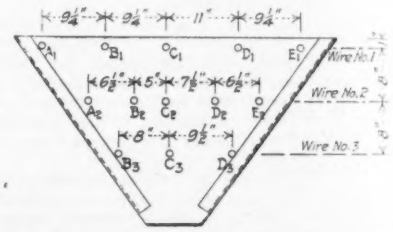

Fig. 3. Diagram of Position of Steel Wires, Showing Points at Which Bulge of Hopper Wall Was Measured.

The assumption of uniform deformation is probably not warranted and therefore the stresses

TABLE III.—UNIT STRESSES IN HOPPER WALL.

		Total load in hopper—				
		Loading in				Drawing out.
Intersection of positions.*	Component.	4,000	8,000	12,000	16,000	12,000
Nos. 1 & 4	Hor.	+1,765	+1,521	+2,450	+1,860	+ 950
	Vert.	+ 432	— 280	+1,045	— 970	—1,761
Nos. 1 & 5	Hor.	+1,580	+1,265	+1,590	+2,190	+1,216
	Vert.	— 312	—1,300	—2,790	— 273	— 695
Nos. 1 & 6	Hor.	+1,060	+1,615	+2,070	—1,281	+ 202
	Vert.	—2,400	+ 76	— 855	—3,430	—4,760
Nos. 2 & 4	Hor.	+ 440	— 589	— 787	—3,800	—2,730
	Vert.	+ 101	— 808	+ 212	—1,628	—2,680
Nos. 2 & 5	Hor.	+ 255	— 842	—1,745	—3,500	—2,465
	Vert.	— 648	—1,835	—3,625	—1,690	—1,648
Nos. 2 & 6	Hor.	— 257	— 500	— 950	—4,380	— 347
	Vert.	—2,725	— 453	—1,690	—4,690	—5,700
Nos. 3 & 4	Hor.	+ 320	—1,170	+ 592	—1,743	—1,950
	Vert.	+ 73	— 953	+ 555	—1,870	—2,490
Nos. 3 & 6	Hor.	— 388	—1,078	+ 110	—2,330	—2,700
	Vert.	—2,760	— 597	—1,340	—4,180	—5,480
Nos. 3 & 5	Hor.	+ 135	—1,425	— 371	—1,603	—1,680
	Vert.	— 714	—1,960	—3,420	—1,183	—1,420

*Positions indicated in Fig. 2.

*Professor of Structural Engineering, Ohio State University, Columbus, Ohio.

given in this table may be considerably in error, but they give a general idea of the probable stresses.

Conclusions.

From the linear deformations, we may conclude with reasonable assurance that there is compression along the horizontal bend line (position No. 1), and that for this hopper and load the maximum unit stress anywhere does not exceed about 10,000 lbs. per sq. in. either in tension or compression. This is allowing a margin for ignorance of about 50% on Table III.

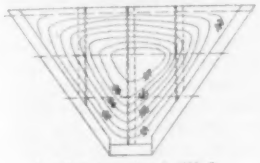

Fig. 4.

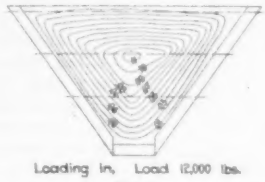

Fig. 6.

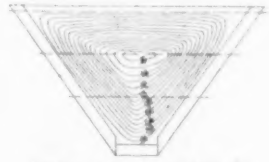

Fig. 8.

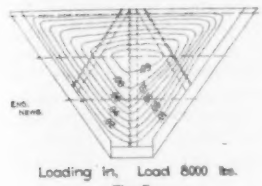

Fig. 5.

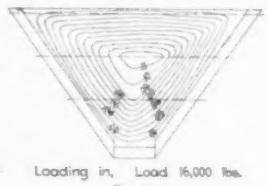

Fig. 7.

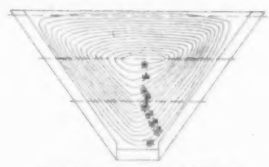

Fig. 9.

FIG. 4-9. CONTOURS OF BULGE IN FOUR-SIDED HOPPER.

Certainly the elastic limit was nowhere exceeded, as there has been no permanent deformation.

The bulge readings gave much more consistent results, and from these it is evident that the stresses on the bottom are much greater after the opening of the valve in the bottom than during the loading in. This is due to the breaking of the natural arch action of the material by opening the valve in the bottom and thus, as it were, removing the keystone of the arch. These readings also show that there is very little increase in stress on the bottom after the level of the top of the load has reached a point about half the width of the bin above the bend line. This is seen by comparing Fig. 10 and the levels of the different loadings as shown in Fig. 1. This point, of course, would vary with the angle of repose of the material.

STIFFENERS.—As stated before, the hopper was in no way overstrained by the loads applied and the maximum bulge (less than 3-16 ins.) was not excessive. This leads to the conclusion that stiffeners would be unnecessary in a hopper of the proportions of this one, designed to carry this material. Also that a much larger ratio of unsupported width to thickness of plates might be used if a lighter material were to be carried.

The purpose of stiffeners on a structure is to prevent the buckling of a plate due to compression or bending. The contours of Figs. 4 to 9 show conclusively that stiffeners parallel to the corners of the hopper would be of no value in resisting bulge, but that they should run in a direction to cross as many contour lines twice, as possible. This would lead to the conclusion that the stiffeners should run either vertically, as shown in Fig. 4, or inclined in the directions indicated by the dotted lines in Fig. 5.

As there is compression along the horizontal bend line, it is possible that a bin might fail by buckling at this point, so a horizontal stiffener around the bin here might be on the side of safety, although the bend in itself strengthens this point against compression. There was very little bulge along this line, as is shown by Table II., and the curve shown in Fig. 10, for point C_1.

THE DUMBARTON CUT-OFF of the Southern Pacific Ry. across the head of San Francisco Bay was opened to traffic on Sept. 24, 1910. The crossing starts near Newark, on the existing line extending along the east shore of the bay, to Dumbarton Point on the west shore. Some 30 miles of distance is saved on the line around the bay to San Francisco. It contains a 310-ft. swing-span in the channel, and six 180-ft. steel spans near the easterly end, in addition to some 6,400 ft. of pile trestle.

Electric Power and Lighting in Railway Shops.*

Special mention should be made of the Readville, Mass., shop of the New York, New Haven & Hartford Ry., where alternating current is used throughout, including all individual machine-tool drives and cranes. While such an arrangement provides many advantages in flexibility, efficiency and possibly decreased operating expenses as applied to generation of power, it is obviously necessary to use belts and cone pulleys at a great many of the machine tools in order to secure speed variation. Thus one of the main advantages of individual motor drive, namely, facility of speed control, has been eliminated. Alternating current should be used as extensively as possible, but not in such a manner as to be detrimental to maximum shop production.

It is generally conceded that the prime generating units should be alternating-current and that synchronous motor-generator sets of sufficient capacity should be used to obtain direct current for operating individual motors on variable-speed machine tools. The use of direct current is sometimes extended to cranes, transfer tables and turntables. Recent experience, however, in the use of alternating current for these purposes has been wholly satisfactory, and a reduction in first cost, as well as operating expenses, can be made by using direct current for the operation of variable-speed motors on machine tools only.

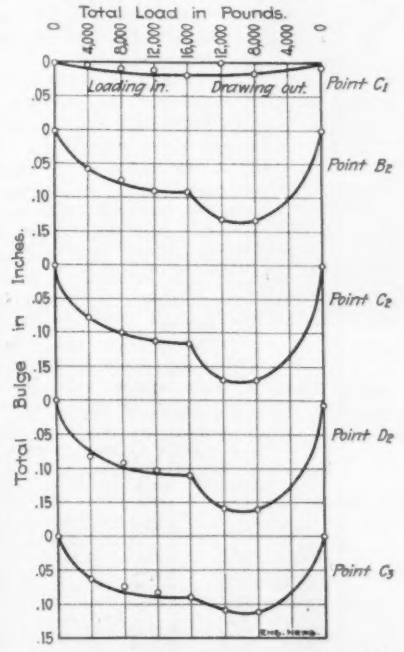

Fig. 10. Curves Showing Change in Bulge of Hopper Wall Under Different Loadings.

(Positions of points C_1, B_2, etc., are shown in Fig. 3.)

The use of a. c. as against d. c. motors in cranes should receive the most serious consideration. No other argument than increased first cost can be sustained against the use of alternating-current motors in crane practice. It has been demonstrated in numerous instances that a fine regulation of speed control can be obtained for handling material in and out of machines and this, together with low maintenance charges, should convince the engineer of the advisability of an a. c. crane-motor installation. These remarks apply equally to transfer and turntable equipments as for other installations where motors must have similar characteristics.

There seems to be an increasing sentiment on the part of machine-tool builders to furnish all-gear speed-change machines, which can readily be standardized for either belt or constant-speed motor drive. It is doubtful whether this is a step in the direction of increased production, toward which every effort should be turned on account of the constant increase in cost of labor. There is no doubt that the facility with which a speed change can be accomplished is the determining influence on the part of the machine-tool operator to increase or decrease speed as conditions warrant and in no manner can it be more readily effected than through the medium of a controller to vary the field strength of the motor. There has also been expressed, by parties familiar with the subject, grave doubt as to the efficiency and life of the numerous gears necessary to produce a reasonable speed variation.

In the machine-tool installation for the new shops of the Lake Shore & Michigan Southern Ry. at Elkhart, Ind., variable-speed motors will be used for all tools wherein an advantage can be obtained thereby.

On account of the cost incidental to individually equipping all machine tools with motors, many engineers group the smaller machines on sections of line shafting operated by motors of the correct capacity. The proper size of motor for any designated grouping of machine tools is a question that can only be decided by knowledge of the number and character of machines, and general shop operating conditions. As a general proposition, the capacity of motor for operating a group of machines should be about 50% of the combined capacity of motors which would be applied to tools if individually driven.

The low cost of power now quoted by central stations, both steam and hydroelectric, has given an incentive to purchase current, in which case a large part of the initial outlay otherwise necessary for generating station equipment is avoided. The purchase of current is especially desirable for small shops and terminals, where the cost of a generating plant would be out of proportion to the service rendered.

ELECTRIC LIGHTING OF SHOPS AND ROUNDHOUSES.—One of the most difficult questions to decide is the proper method of lighting in the various shop buildings. Until quite recently carbon-arc lamps for general illumination and incandescent lamps for localized light at the various machines, etc., were the accepted medium for shop lighting. The advent of flaming-arc lamps, titanium arcs and tungsten lamps promotes better lighting.

Due to the elevation at which cranes must operate in the erecting shop it has been extremely difficult to secure proper illumination at the floor level. Some engineers preferred hanging arc lamps above the cranes and others located them between the columns at each side of shop at a much lower elevation. Both systems are open to objection, however. In the first case, so much of the light is absorbed before reaching the working level that only by the use of an inordinately large number of lamps could successful results be obtained. In the second case objectionable shadows are cast by the columns and locomotives on the erecting floor.

It is evident that the proper place to hang the lamps is above the cranes, and a much more powerful illuminant can now be furnished in the form of flaming or luminous-arc lamps, either of which overcomes the tions mentioned.

Lighting of the machine shop can be accomplished far better by a good general illumination, more nearly approaching daylight, than by local illumination at each machine. Those who have had experience in the maintenance of lamps, sockets and drop cords, can vouch for the troubles which prevail, due to entanglements with gearing, soaking with oil, water, etc.

By placing high-power tungsten lamps at an elevation of 10 to 12 ft. above floor level, properly spaced, the low section of machine shops can be adequately lighted. Blacksmith shops and foundries should be lighted with arc lamps exclusively.

Another bugbear to the electrical engineer is the roundhouse illumination, as the roundhouse must operate at night as well as by day. Every known method of lighting has been used and there is no system recognized as superior to others. Carbon-filament incandescent lamps of 16 c. p. placed at an elevation of about 7 ft. proved unsatisfactory both on account of the insufficient amount of light obtained and the difficulties attending maintenance. A number of roundhouses are lighted by using an arc lamp for each pit. This offers objections on account of the difficulty attending trimming lamps, and also the corroaive effect of the prevailing gases.

Probably the best results can be obtained by placing four 100-watt tungsten lamps between every pair of pits, at an elevation of 12 or 15 ft. These would give light to all parts of the engine and provide a total of 320 c. p. at a current consumption of approximately ½-watt per sq. ft. floor area.

*Abstract of the report of the Committee on Shop Practice, presented at the annual meeting of the Association of Railway Electrical Engineers at Chicago, Sept. 27 to 30.

Tests of Reinforced Concrete Slabs.

During the construction of the buildings for the new Cook County Poor Farm, at Oak Forest, Ill., the opportunity was taken to make tests of some experimental slabs of reinforced concrete having the steel reinforcement arranged in different ways. The tests were made by Holabird & Roche, the architects, and the Alling Construction Co., the contractor, both of Chicago, and we are indebted to the architects for particulars of the work and the results. The objects of the tests were as follows: (1) to determine the value of different methods of placing the reinforcing steel, in regard to strength and deflection of slabs, stress in steel, etc.; (2) to determine the load and deflection of the first noticeable crack; (3) to compare the stresses obtained from the tests with those computed from commonly accepted formulas.

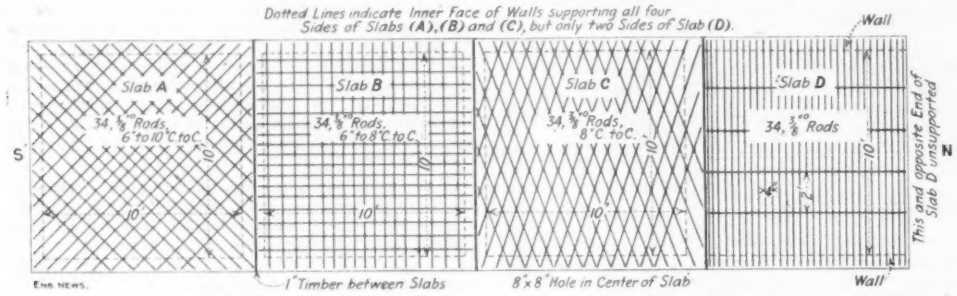
Dotted Lines indicate Inner Face of Walls supporting all four Sides of Slabs (A), (B) and (C), but only two Sides of Slab (D).
Wall
Slab A
34, ½" Rods, 6" to 10" C. to C.
Slab B
34, ⅜" Rods, 6" to 8" C. to C.
Slab C
34, ⅜" Rods, 8" C. to C.
Slab D
34, ⅜" Rods
S
N
10'
This end opposite End of Slab D unsupported
1" Timber between Slabs
8"x8" Hole in Center of Slab
Wall

FIG. 1. ARRANGEMENT OF STEEL BARS IN TEST SLABS OF REINFORCED CONCRETE.

Four slabs were built on brick walls 8 ins. and 12 ins. thick. The three slabs reinforced in two directions were supported on all four sides; while the slab (D) reinforced in one direction only was supported on two sides. Each slab was of the same span (10 ft.), the same thickness (4 ins.), and with the same number and size of reinforcing rods. The arrangement of the slabs and rods is shown in Fig. 1.

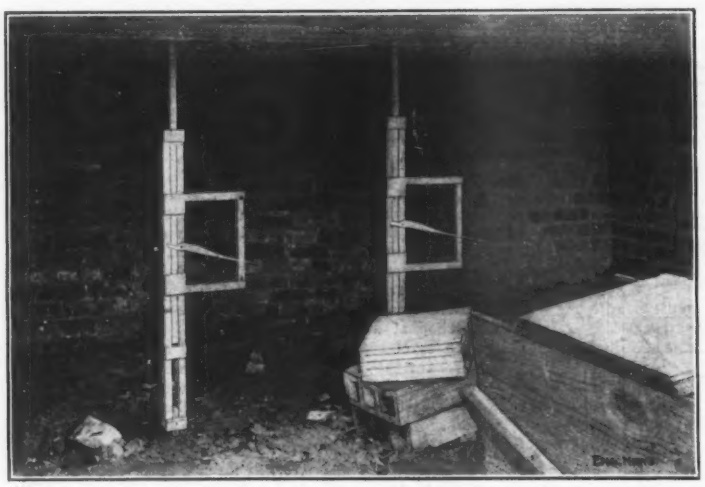

FIG. 2. DEFLECTOMETERS UNDER TEST SLABS.

The slabs were made Sept. 22, 1909, using the same grade of concrete as that being poured for the first floor of one of the buildings. They were tested Nov. 10 and 11, giving an age of 49 days. All concrete was made in a machine mixer of the batch type, and the materials were proportioned by volume; the proportions were 1:2:4, using Portland cement, limestone screenings, and crushed limestone of ½-in. size and under. The mixture was quite wet or "sloppy." The reinforcement in each case was of ⅜-in. round rods made from high-carbon re-rolled rails; elastic limit, 61,100 to 82,420 lbs.; ultimate strength, 88,030 to 130,040 lbs.; elongation in 8 ins., 14 to 19.7%; fracture, square; cold bend, 180° around twice the diameter.

The brick supporting walls were built to an average height of 3½ ft. to allow the placing of deflectometers and to give access beneath the slabs. Fig. 2 shows the deflectometers in place, the upper part of the post being pushed down by the deflection of the slab and moving the short end of the lever, whose larger end traveled over a graduated bar. An opening 8 × 8 ins. was left in the middle of each slab, so that the deformation of the concrete could be observed without disturbing the loading. Near the center of the slab were placed metal inserts; those in the top of the slab were about 15 ins. apart and embedded in the concrete; these in the bottom of the slab were clamped to one of the rods passing through the central opening. Fig. 3 shows the general arrangement. Each lower insert had a hole to receive the steel rod, and was clamped in position by a vertical set screw in the top of the insert. In slabs (A), (B) and (D), the inserts were so placed that deformation of the concrete was determined in the direction of the rods, and in slab (C) at an angle of 22½° to the rods and normal to the sides of the slabs.

The deformation in steel and concrete was determined by measuring the distance between the inserts at the different loading by an inside micrometer reading to 0.0001-in., at least three readings being taken for each load recorded. The deflection was measured at the center and quarter point of each slab by a deflectometer arranged with an arm multiplying the movement by 8, and reading to 1-128-in. All readings were checked by a second observer to reduce the chance of mistakes. The records summarized in Table I. are the averages of the readings. The loading consisted of sacks of crushed marble (111 lbs.) and cement (96.6 lbs.); these were stacked in piles, care being taken to leave spaces between the piles, so as to prevent arching of the load. The loaded area was 117.28 sq. ft. for slabs (A) and (B), 121.88 for (C), and 115 for slab (D). In computing the load per sq. ft. only the load directly on the clear span was considered.

In all calculations, the value for modulus of elasticity was assumed as 30,000,000 for steel and 2,000,000 for concrete. Slabs (A), (B) and (C) showed no signs of failure at any time and it is to be noted that the load of 920 lbs. remained on slab (B) over night with only ¼-in. increase in deflection. Slab (D) showed signs of failure when loaded to 554.8 lbs.; the load was increased to 655 lbs., when the deflection was 4¾ ins., having increased very rapidly after the 554-lb. load.

The general results are shown in the accompanying tables, and in the diagrams, Fig. 4. In every case, the stress in concrete as computed is from the deflection much lower than that computed by either the straight-line or the parabolic formula, being usually about 82% of the stress computed by the latter formula. This agrees very closely with stresses computed from radial moments for square slabs, considering the concrete to be compressed radially about the center of the slab. The stresses in the steel as computed from the deformation of slabs (A) and (B) agree very closely with those computed by the use of both the straight-line and the parabolic formulas. The tests of slabs (A) and (B) are considered very fair; slab (C) developed greater strength and rigidity than a large slab of this order supported on two sides only. The test of slab (D) was conducted with too much speed to get many readings of the deformation in steel and concrete.

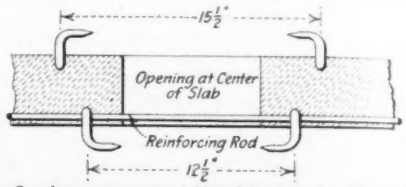

Fig. 3. Arrangement of Metal Inserts for Measuring Deformations of Concrete and Steel in Test Slabs.

Fig. 5. shows the characteristic cracks in the slabs, under given loads. In all the slabs supported on four sides, diagonal cracks were first observed. The cracks in slabs (A), (B) and (C) were hair cracks and were traced with difficulty.

TRACK ELEVATION IN CINCINNATI, O., may be taken up actively next year. A bond election is to be held this fall, and if the results are favorable it is probable that a considerable amount of track elevation work will be done. Complete plans have been worked out for the elimination of the greater portion of the grade crossings, but no construction has been done as yet, owing to lack of available funds on the part of the city. A franchise has been granted recently for a new union passenger station, including extensive terminals, but the final plans for this new terminal system are not yet completed.

TABLE I.—DEFLECTION AND STRESSES OF TEST SLABS.

Slab.	Load per sq. ft. lbs.	Deflection. ins.	Deformation between inserts. Steel. ins.	Deformation between inserts. Concrete. ins.	Stresses computed from Deformation. Steel.	Stresses computed from Deformation. Concrete.	Stresses computed from Straight-line formula. Steel.	Stresses computed from Straight-line formula. Concrete.	Stresses computed from Parabolic formula. Steel.	Stresses computed from Parabolic formula. Concrete.
A	168.5	1/16	0.0057	0.0042	8,400	....	....	....	21,620	....
A	*391.0	⅛	0.0104	0.0134	52,800	800	49,670	1,440	49,700	*956
A	465.2	95/128	0.0331	0.0167	....	....	50,660	1,526	51,700	1,000
B	316.8	9/64	0.0096	0.0080	16,980	....	....	....	35,870	....
B	*448.5	95/128	0.0340	0.0101	58,200	820	52,440	1,620	54,530	*1,050
B	631.6	21/32	0.0419	0.0122	71,700	800	73,740	2,290	75,100	1,450
B	920.0	1¼	....	....	....	....	107,680	3,335	111,860	2,150
C	*384.1	11/32	0.0133	0.0113	21,000	640	58,500	1,580	60,150	*1,020
C	554.3	81/128	0.0208	0.0153	45,300	1,100	84,500	2,280	86,830	1,470
C	633.5	55/64	0.0232	0.0200	....	....	96,600	2,600	99,250	1,680
D	554.6	...	....	....	....	....	88,300	3,550	84,130	2,100

*First crack.

TABLE II.—LOADS AND DEFLECTIONS OF TEST SLABS.

Slab	A	B	C	D
Direction of reinforcement	Diagonal	Rectang.	Diagonal	Rectang.
Deflec. at approx. equal loads, ins.	3/128	2/128	3/128	6/128
Load for this deflec., lbs.	83.3	85.2	82.0	77.2
Comparative stiffness	2	3	2	1
Load at 1st crack, lbs. per sq. ft.	391	448.5	384	288
Max. load on slab, lbs. per sq. ft.	465	920	633.5	554.8
Max. deflec. under max. load, ins.	95/128	1¼	53/64	1
Deflec. after load removed, ins.	5/16	½	27/64	(5/16)
Value of load at 1st crack minus dead load divided by 2.	170	200	168	129
Load nearest (below) deflec. of 1-800 at center	242.7	318.8	231.6	177.2
Deflec. at center at 1st crack, ins.	⅛	65/128	11/32	9/32
Ditto divided by span	1-254	1-236	1-349	1-214
Max. bond developed, lbs. per sq. in.	150	300	286	242 (fail by compress.)

Convention of the Association of Railway Electrical Engineers.

The third annual convention of the Association of Railway Electrical Engineers was held at the La Salle Hotel, Chicago, on Sept. 27 to 30. It was the first convention under the present name, the organization having been originally the Association of Car Lighting Engineers; the society is still occupied mainly with matters relating to car lighting by electricity. The principal matters relative to other subjects were a report on electric power and lighting for railway shops and two papers on car ventilation and the electrical operation of drawbridges.

The chair was taken by the President, Mr. E. M. Cutting (Engineer of Train Lighting and Heating, So. Pac. Ry.). The attendance at the meetings was small, especially as there are reported to be over 400 members. There was very little discussion on technical matters, but considerable time was devoted to business matters.

The report of the Committee on Standards reported that the train-lighting lamps recommended by this Association and the National Electric Lamp Association are now being used. In regard to train lighting systems it stated as follows:

> Current of 60 volts for trains lighted by head-end systems, and either 60 volts or 30 volts for straight storage and axle-dynamo systems, was recommended by the Master Car Builders' committee at the June convention. We believe that those two voltages will be necessary for the present, or until such time as the development of electrical apparatus makes the lower voltage applicable to all systems. The 64-volt head-end system has gained some ground this year. One eastern road has adopted it as standard. One western road changed over two of its 110-volt trains and is getting ready to apply it to 18 new trains.

The Committee on Accounts and Reports pointed out the necessity of a standard method of calculating and reporting the cost of car lighting, and made the following recommendations: (1) the standard units of cost to be the car-month and the 1,000 car-mile; (2) the car-month shall be one car equipped for service for one calendar month, no deductions being made for service conditions or stopping periods; (3) the car mileage shall include all mileage made by a car, regardless of service conditions; (4) a complete report on the cost of car lighting should include supervision, all labor, material and charging current, interest and depreciation on the entire investment, cost of power for operating head-end equipments and axle dynamos, cost of hauling the apparatus, and insurance and taxes. The cost of haulage of the equipment is given as varying between three and six mills per ton-mile. For depreciation, the committee recommends an allowance of 8%, as sufficient to replace the investment in ten years.

The report of the Committee on Illumination presented recommendations as to certain carbon, tantalum and tungsten lamps for train lighting, and stated that the number of varieties of such lamps should be as small as possible. The present two standard ranges of voltage for car lighting lamps should be continued; namely, 28 to 34 volts and 57 to 65 volts.

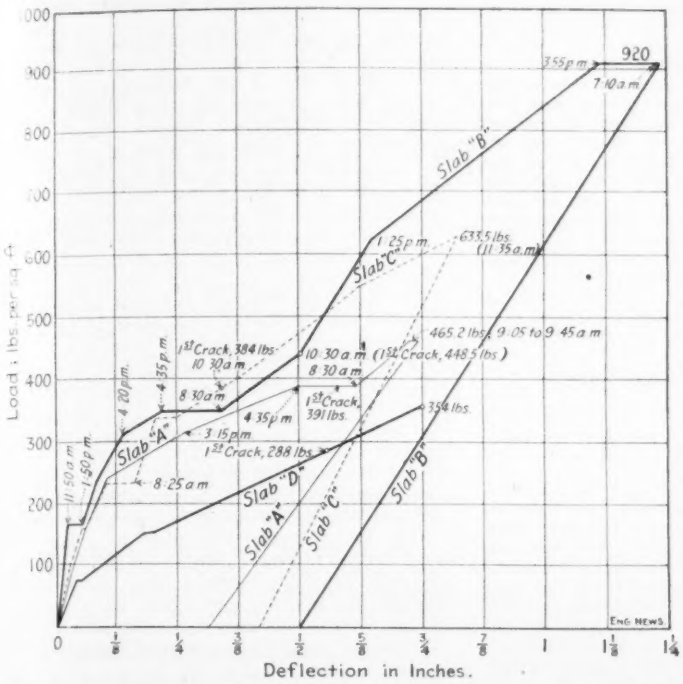

FIG. 4. DIAGRAM OF DEFLECTIONS OF TEST SLABS UNDER LOAD.

The carbon lamp with its low efficiency has been superseded by the tantalum lamp, and this in turn has been largely replaced with the tungsten lamp. The latter, when first introduced, was found to be fragile, but by improvement in both the quality of the filaments and methods of support, the lamp is now found suited to all classes of service.

There have been placed upon the market various advanced types of tungsten lamps, such as the "spring support" lamp in which the stem of the lamp is mounted on a wire spring, and the "wire" type continuous filament tungsten lamp. Perhaps the most interesting development is the new drawn wire filament.* This lamp gives a long, useful life and is sufficiently strong mechanically to fulfill the conditions demanded by train lighting service.

This remarkable progress in the development of tungsten-filament lamps, especially train-lighting types, is shown from the fact that one year ago only one railway had standardized the tungsten lamps to the exclusion of all other types, while to-day practically all the railways in the country are using this type of lamp, with entire satisfaction.

CAR VENTILATION.—A paper by Mr. B. A. Stowe advocated the general use of exhaust fans, but the members seemed to think the problem less easy of solution than the author suggested. The subject was discussed by Mr. W. H. Lynch, of Chicago, an inventor of ventilating apparatus. He considered that too much attention is given to the quantity of the air to be supplied, and his point of view was that the quality of the air supply and its distribution throughout the car or room were of much greater importance. Some extracts from the paper are given below:

> I recommend 30, 60 or 110-volt direct-current supplying small exhaust fans, located back of the deck sash and communicating with discharge flues carried over the car roof in a manner similar to the Garland ventilator.†

*Described in Engineering News, July 7, 1910.
†Engineering News, Dec. 23, 1909.

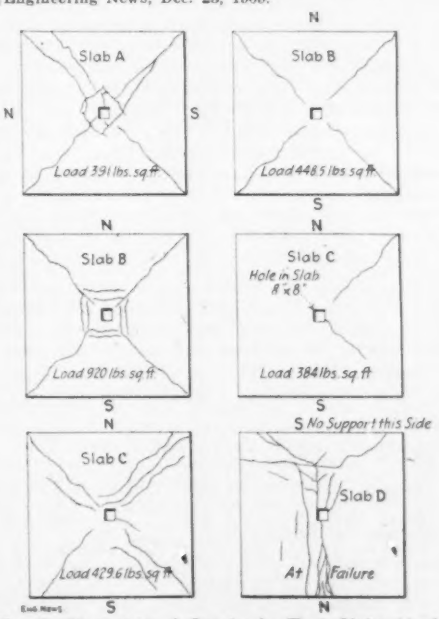

Fig. 5. Character of Cracks in Test Slabs Having Different Arrangements of Reinforcing Rods.

The preferred method of wiring such fans would be to provide two multiple circuits, one on each side of the car, controlled independently by switches operated by the proper car official. Such subdivision of the circuit would permit of adjustment to meet conditions of wind or smoke.

Limitations of space largely determine the size of fan. Presumably a 9-in. propeller would be found to meet general conditions. The number of fans per car would depend upon the degree of ventilation desired. There are 9-in. fans which will displace 330 cu. ft. per min. or over 31,000 cu. ft. per hour. The 12-in. fans for 1,100 cu. ft. per min., would be better on account of a somewhat higher efficiency, but as it is desirable to place such motors back of the deck sashes in order not to prevent closing them in the face of a storm or high wind, the 9-in. size will probably be preferable. On cars equipped with Garland ventilators, 9-in. fan exhausters may be, and have been installed between the deck sash and the inductor end of the ventilator, thus utilizing the present discharge flues.

Ventilation in the sense of supplying more or less pure air, is not accomplished by the fan located at either end of the car. The function of such fans is to create within the car local currents of air. Thus the air does not become stagnant, and while it may be foul, the sense of oppression is counteracted by a certain stimulation due to the current of air. The effect of such air currents is immediate and the superficial results are often confounded with such as may obtain only from pure air.

Electric fans are often installed without due regard to economic distribution or to their effect. Many persons are susceptible to a sustained draft or current of air, especially if the current is directed at the back or neck. Under certain conditions fans may be very annoying, if not positively dangerous.

There were numerous exhibits of lamps and train-lighting apparatus, but as these were displayed in the room in which the meeting was held the noise and confusion incident to their demonstration was so great that after the first session it became necessary to exclude exhibitors and visitors while the meetings were in progress. An interesting feature was a demonstration of the gyroscope, which attracted more attention than any of the technical features of the program.

The election of officers resulted as follows: President, J. R. Sloan, Electrical Engineer, Pennsylvania R. R.; Secretary, Joseph Andreucetti, Assistant to the Electrical Engineer of the Chicago & Northwestern Ry., Chicago. The next meeting will be held at Kansas City, Mo.

FLEXIBLE STEEL BELT CONVEYORS have been recently put on the market by a Swedish manufacturer and a number of installations of this new type of conveyor have been made in northern Sweden. A hardened steel ribbon, or belt, from 8 to 16 ins. wide and 0.03 to 0.04-in. thick runs flat on the bottom of a trough with sloping side-boards. The belts are made in lengths up to 328 ft. and longer belts can readily be obtained by riveting two or more lengths together. The belts are run on wooden pulleys covered with rubber belting. The driving pulleys should be 3.28 to 4 ft. in diameter, and the idler pulleys 16 to 20 ins.

It is stated that these belts are suitable for transporting ore, coal, planks, wood stumps, coke, cement slag, ashes, sawdust, etc., and that the power cost and cost of upkeep and repair is inconsiderable. In case of fracture, a riveted piece can be inserted. They are known as Sandvik belts and are made by the Sandvikens Jernverks Aktiebolag, Sandviken, Sweden. An illustrated description was published in the "Engineering and Mining Journal," Sept. 3, 1910.

ALTITUDE OF SOME SOUTH AMERICAN RAILWAY LINES.—At the present time there can be no doubt that the Antofagasta & Bolivia Ry. Co. can claim the distinction of having the highest railway in the world. This railway has a 2-ft. 6-in. gage. Over this route the company runs sleeping and day coaches from Antofagasta on the Chilian coast to Oruro, 574 miles distant. From Antofagasta the line gradually rises to an altitude of 13,000 ft., which is reached at Ascotan, 223 miles from Antofagasta, and the main line runs for many miles at an almost uniform level of 12,000 ft. above the sea. The claim in respect of being the highest line of railway in the world is made not for the Antofagasta main line, but for the branch line which runs from Ollague to Collahuasi, on which the rails are laid at the great height of 15,809 ft. above sea level. Moreover, even this great altitude will, it is stated, be exceeded on the branch lines now being constructed by the Antofagasta Co. from Rio Mulato to Potosi. This is a line of a meter gage, and it is believed that the rails will reach a height exceeding 16,000 ft. At the present time the distinction of possessing the second highest railway in the world may be claimed for the Oroya Railway in Peru, where the line attains an altitude of 15,583 ft. The third highest line of rails is on the Peruvian Southern system, where a height of 14,665 ft. is reached at Portez del Cruzera. The greatest height prevailing on the Argentine and Chilian Transandine Ry. is 10,466 ft.—London "Times," Aug. 30.

The Neutralization and Filtration of Smelter Smoke.*

By W. C. EBAUGH.†

In the Journal of the American Chemical Society for July, 1907, there appeared a series of articles dealing with various phases of the smelter smoke problem, and presenting the matter from points of view that were quite different from one another.

In one of the articles special stress was laid upon the method of measuring the velocities of gases and determining the quantities of solids sent out of a stack during a given time. The results were startling to one who had had no previous experience in work of that kind, and probably awoke a new train of thought in the minds of all concerned with the problems of economic smoke handling and treatment.

A second article pointed out the damage that could be done by even small quantities of sulphur dioxide in the atmosphere, if present a large amount of the time, and cited experiences in many fields to bear out the statements made. The effects of arsenic escaping with the smoke and of copper bearing water issuing from a metallurgical plant also received attention.

The third article dealt with a comparison of the action of gaseous and solid emanations from smelters, and tried to show that although the damage done to crops by sulphur dioxide in certain climatic conditions might be enormous, nevertheless in the dry atmosphere of the intermountain west perhaps the importance of the gases in producing damage might have been overestimated, and the importance of the solid emanations might have been underestimated. The role of the solid emanations in injuring stock had already been acknowledged, but its importance in causing injury to vegetation had not been given the attention that it merited.

As the result of litigation long drawn out, in 1906 four smelters in the Salt Lake valley were enjoined from operating, the court decreeing that in order to be considered harmless a smelter should treat ores that in their natural state contained not to exceed 10% of sulphur. To comply with such a condition was a commercial impossibility, and a petition that the smelters be allowed to mix ores in such a way that the average sulphur content should not exceed 10% was presented to the court, but the petition was denied. On appeal the circuit court affirmed the decision of the district court in all material points. Two smelters then went out of commission. A third entered into an agreement with the plaintiffs to filter all the solids from its blast-furnace gases and to send its roaster gases through some 1,800 ft. of Monier flue and a cooling and expansion chamber of specified construction, and a modification of the injunction was therefore permitted by the court in the case of this party to the suit. The fourth smelter went at the matter somewhat differently, and as a result of many months of experimenting evolved a system for neutralizing the gases from its devices, other than blast furnaces, in such a way as to permit their filtration. When their plans had been perfected the case was reopened before the district court, and upon the showing made permission was granted to try the new scheme. In other words the injunction was suspended, but not removed.

More or less full accounts of the modifications used have been published in the technical periodicals. A brief résumé may not be out of place. It was shown that the gases coming from lead blast furnaces and from zinc plants had been filtered successfully for many years, but that roaster and other gases were not amenable to such treatment. The reasons for the latter statement are (1) that the temperature of gases coming from roasters is so high as to make the cooling of the gases before filtration impracticable or at least unprofitable; (2) that such gases contain more sulphur trioxide than do those from lead and zinc furnaces, and therefore corrode the bags vary rapidly; and (3) that finely divided carbon and fume coming from roasters of the ordinary types seem to result in frequent cases of spontaneous combustion in the bag house, with consequent loss of efficiency and greatly increased cost of operation. Messrs. Sprague and Rhoades found that it was possible to prolong the life of a bag indefinitely if the gases led into it were first neutralized with zinc oxide. Experiments upon a larger scale were then conducted, and as a result they proposed to neutralize all the gases coming from a lead plant, roasters as well as blast furnaces, and filter the cooled mixture through bags. The plant was remodeled accordingly, and has now been in use for about two years. The success that has attended its operation under the new plan of operation has given great satisfaction to all concerned. Looking at the plant one would think that it was out of commission, or at least running only a battery of ordinary steam boilers, for the only stacks that seem to be in use are those on the power-house. Prior to the changes the vegetation in the neighborhood of the plant was always more or less injured by products thrown off by the smelter, but repeated examinations of these same districts during 1909 and 1910 have failed to disclose any damage that could be detected by the casual observer. The latter part of the summer of 1909 was unusually wet, and the spring and summer thus far this year have been unusually dry and hot, but the surrounding country has never looked better, according to impartial observers, than during these two seasons.

After the lead plant had been in operation for some months the court granted permission to start the copper plant under similar restrictions, but the company has not taken advantage of this decree. Failure to do so is to be attributed more to economic than to technical or metallurgical causes.

That the improved state of affairs is really due to the changed methods of operation rather than to climatic or other conditions is shown by the fact that other plants working on a similar scale to the one herein referred to, but without such efficient filtration for all gases, have not been surrounded by an unharmed area. Since sulphur dioxide and other flue gases are thrown off into the air in all cases, and only the solids are retained by filtration, it seems that there is some connection between the solids emitted and the damage inflicted upon vegetation, thus affording proof for the conclusions offered three years ago.

At best the results can be taken only as a "report of progress." Theoretically and practically the escape of sulphur dioxide into the air constitutes an economic waste in the broad sense of the term, and were it possible to convert this gas into sulphuric acid and find a market where it could be utilized directly or indirectly at even a small margin of profit, a new and better method of disposing of this smelter waste might be introduced. At present, however, such a plan appears to be impracticable. Figures taken from the United States Census for 1900 and from various trade reports formed the basis for a calculation made several years ago, that showed that the smelters of Utah alone would be able to make more sulphuric acid than was consumed in the whole United States. If to this enormous output be added that obtainable from Montana, Arizona, California, Washington and other smelting states, the magnitude of the undertaking could be appreciated. The matter of freight rates from smelting districts to localities in which there is manufacturing on a large scale must also be taken into account. It would seem that for the present at least filtration of smelter smoke offers a partial solution of the problem, but that a better means of avoiding damage may be evolved in the future. Most of us who are still in our youth can remember how the rivers near gas works were polluted by tar and other refuse, how certain industrial plants used to belch out great clouds of black smoke 24 hours of the day, and how slaughter-houses treated as waste much of the material that they now turn into profit. Is it too much to hope that changed conditions as exemplified in the gas works, power-houses and abattoirs just mentioned may be tokens of what may occur to smelters in the not very distant future?

*From a paper in the "Journal of Industrial and Engineering Chemistry" of the American Chemical Society, Sept., 1910.

†University of Utah, Salt Lake City.

A Test Run with a Heavy Freight Train on the Pennsylvania R. R.

An exceptionally heavy freight train was operated on the Middle Division of the Pennsylvania R. R. on Aug. 23, as part of a series of experiments in handling very heavy trains. This trip was made to demonstrate the maximum performance of a certain type of engine under the most favorable conditions. The trip was made eastward from Altoona, Pa., to Enola, 127 miles, and information concerning it has been furnished at our request by the officers of the railway.

The engine (No. 1,221) was of the consolidation or 2-8-0 class (Pennsylvania R. R. class H-8-b), having cylinders 24 × 28 ins. and driving wheels 5 ft. 2 ins. diameter. Its boiler pressure was 205 lbs. The engine weighed 238,300 lbs. (with 211,000 lbs. on the driving wheels). The tender, with an average load of coal and water, weighed 143,000 lbs., making a total of [illegible],300 lbs. for the engine and tender.

The train consisted at first of 120 cars, [illegible] one was cut off after about 34 miles. The [illegible] steel cars weighed 2,380 tons empty, and carri[illegible],538 tons of freight (coal), making a total [illegible],778 tons. Including the engine and tender th[illegible] gross weight was 8,968 tons. The train was e[illegible]ped with telephone service to afford commu[illegible]tion between the engine and the caboose, in o[illegible]r to determine whether such service could be o[illegible]ated successfully on a train of this length [illegible]n motion.

On the run from Altoona to Enola the [illegible]m of the vertical elevation of the ascending gr[illegible]s is 232 ft., while that of the descending gra[illegible]s is 1,083 ft. The maximum ascending grades [illegible]e in reaching the McVeytown Summit, where there are 7,500 ft. of 0.141% and 6,200 ft. of 0.[illegible]2%. The elevations above sea level are 1,179 ft. at Altoona, 533 ft. at the McVeytown Summit and 376 ft. at Enola. The sharpest curves traversed by the train (including those at the yards) were 6°. A summary of the run is given in the accompanying table.

Going east from Vineyard the train approached the McVeytown grade at a speed of 24 m. p. h. and passed over the summit at 11 m. p. h. The steam dropped to 165 lbs. pressure at the summit. In the run from Altoona to Denholm (74.7 miles) the speed averaged 14 m. p. h., including stops, or 19 m. p. h., excluding stops. The total run from the Altoona yard to the Enola yard (127 miles) was made in 9 hrs. 36 mins., at an average speed of 13 m. p. h. As a precaution, a light engine followed the train over the division, but the train engine was able to start and handle the train without assistance at any time. The total coal consumption was 26,140 lbs.; 2,295 lbs. per 100 ton-miles.

TRIAL RUN OF A HEAVY FREIGHT TRAIN; PENNSYLVANIA R. R. AUG. 23, 1910.

Stations.	Time.	Length of run, miles.	Speed, m. p. h.	Time of run, h.	m.
Altoona	7:38 a. m.	.....	..	..	..
Warrior Ridge (1)	8:45, 9.09	25.6	23	1	[illegible]
Huntingdon (2)	9:22, 9:42	.....	..	0	[illegible]
Vineyard (3)	10.51, 11:25	19	17	1	[illegible]
Denholm (4)	12:53, 2:05 p. m.	27	19	1	[illegible]
Bailey's (5)	3:28, 4:01	26.01	19	1	[illegible]
Susquehanna Bridge	4:47	15.1	20	0	[illegible]
Enola	5:05 p. m.	.....	..	..	..

1. Stop for water; 24 mins.
2. One car cut off on account of a broken brass; 20 mins.
3. Engine cut off and sent to Ryde for water; 34 mins.
4. Delay of 65 mins. for taking coal and water, cleaning the engine and having the train photographed.
5. Stop for water; 33 mins.

Notes from Engineering Schools.

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS.—A course of instruction in road building will be given during the present year, supplemented by practical road-building work on some of the college property. The new course will be given under the direction of Prof. Robert J. Potts, of the division of highway engineering.

UNIVERSITY OF ILLINOIS.—The Railway Engineering Department has added to its laboratory equipment a drop-testing machine and a brakeshoe testing machine. While the chief purpose in installing this apparatus has been to increase the facilities for instruction and research, it is desired also to extend their use to railways and manufacturers.

The drop-testing machine is of the standard design of the Master Car Builders' Association, and may be used for tests under the specifications of that association and the American Society for Testing Materials, of such materials as axles, car couplers, coupler knuckles, knuckle pins, draft gear, and rails. It is, of course, suitable for making impact tests of other materials. It consists essentially of a hammer weighing 1,640 lbs., sliding down in two upright guides 50 ft. high, between which it is allowed to fall upon the specimen under test. The test specimen is placed upon an anvil weighing about 18,000 lbs., supported from the foundation through the medium of heavy springs.

The M. C. B. specifications for couplers, coupler knuckles, knuckle pins, and axles, requires tests in a machine of this design. The pulling test required for couplers may be made upon one of

standard testing machines, which has a capacity of 600,000 lbs. and which will permit the testing of specimens 25 ft. long. The impact test of rails required under the specifications of the Society for Testing Materials may also be made by means of the drop-testing machine.

The brake-shoe testing machine is similar in design to the original machine built for the Master Car Builders' Association. It consists primarily of a shaft carrying a fly-wheel and a car wheel, driven at any desired speed. By reason of the fly-wheel, there is available at the surface of the car wheel, when in motion, the same amount of energy as is impressed upon one wheel of a 60,000-lb. car in service, under like speed conditions.

The shoe to be tested is suspended above the car wheel from one of a system of levers, by means of which the shoe may be applied to the wheel with any desired pressure up to a maximum of 18,000 lbs. The tangential pull of the shoe, which develops when the shoe is thus applied to the moving wheel, is transmitted to a dynamometer, where it is recorded upon a moving paper chart. By these means, the coefficient of friction of any shoe may be determined under different conditions of speed and shoe pressure. The machine likewise serves to permit the determination of shoe wear and wheel wear under varying conditions. Tests to determine the frictional qualities and durability of brake-shoes may be carried out by this apparatus.

AN EXPLOSION IN A COAL MINE near Muzquiz, Coahuila, Mexico, Sept. 30, entombed about 70 miners.

AN EXPLOSION WRECKED THE BUILDING and plant of the Los Angeles "Times" shortly after 1 a. m., Oct. 1. A fire following the explosion completed the destruction of the building. Nineteen men are reported to have been killed, although only twelve bodies have been recovered from the ruins.

A BUTTING COLLISION OF TROLLEY CARS took place on a sharp curve on the Illinois Traction System's line, two miles north of Staunton, Ill., Oct. 4. Both cars were running at a speed of about 40 mi. per hr. and were telescoped together. The four men composing the two car crews escaped with slight injuries by jumping, but about 35 passengers were killed and 25 others badly injured. The accident is ascribed to disregard of meeting orders.

This accident is similar in all essential details to the one at Kingsland, Ind., Sept. 21 in which 40 persons were killed, and to the one near Tipton, Ind., Sept. 24, which killed six persons.

A U. S. NAVY LAUNCH SANK in the Hudson River off 157th St., New York City, Oct. 1, and 29 of the 89 men on board are missing and are supposed to have been drowned. The accident occurred early in the evening. The boat was a "sailing launch," described as a flat-bottomed boat 40 ft. long with 8-ft. beam. The accident occurred while the launch was being towed by a cutter from the 157th St. wharf to the U. S. Battleship "New Hampshire," anchored in the river. No definite explanation of the accident has yet been advanced.

A HEIGHT RECORD for aeroplane flight is reported from Mourmelon, France, where Henri Wynmalen on Oct. 1 rose to 9,121 ft. above ground. At that altitude his carburetor froze and his engine stopped so that it was necessary to coast to earth.

THE COLUMBIA RIVER BRIDGE, now under construction for the North Coast Ry., is notable in having wood truss spans. It has 12 concrete piers, and all but three of these were completed before the annual high-water period of June and July. The superstructure consists of nine wood Howe truss spans of 150 ft., and a wood swing span of 240 ft., giving two openings 100 ft. wide in the clear. The trestle approaches aggregate 952 ft. Mr. F. L. Pitman is Chief Engineer of the railway, and the Puget Sound Bridge & Dredging Co., of Seattle, Wash., has the contract for the bridge. All the piers are now finished and it is expected to complete the superstructure by November.

SLIDING GROUND SHIFTED A BRIDGE of the Great Northern Ry. over the Red River of the North at Grand Forks, N. D. Supplementing a brief note printed in our issue of Sept. 22 we have the following more explicit information from Mr. J. A. Bohland, Bridge Engineer of the railway: The west bank of the river at the crossing has been sliding at the rate of 4 to 6 ins. per year, carrying with it the bridge west of the draw-span. The bridge contains a 196-ft. steel swing-span on masonry center pier and east rest-pier and timber west rest-pier. The west approach contains a 150-ft. through-truss Howe span and 162 ft. of pile trestle. The sliding ground shifted the trestle, the Howe truss span and the timber rest-pier of the draw, requiring occasional repair and shifting work. During 1910, however, the rate of sliding has been enormously increased, totaling about 4 ft. 6 ins. to date, with a highest rate of 4 ins. per week. The Howe span has had to be moved back about 5 ft. and the piers have been widened to correspond.

A FIRE IN NEW YORK CITY Oct. 3 swept both sides of Eleventh Ave. between 24th and 25th Sts., and spread east between those streets half way to Tenth Ave. Some buildings on the south side of 24th St. were also burned. The fire started in the lumber yard of the Moore Brothers Lumber Co., which was entirely consumed. The total loss is estimated at $1,500,000.

RAPID TUNNEL ADVANCE was accomplished on the Catskill Aqueduct during September, 1910. Heading 3 N. of the Wallkill Siphon tunnel made an advance of 523 ft., the full section excavation keeping even pace with the heading. This tunnel is circular, 17 ft. diameter inside of neat line. It lies mainly in Hudson River shale, and the work of this heading during the month was in alternating layers of slate and sandstone.

The Bonticoir grade tunnel of the Aqueduct, 7,000 ft. long, passing through the Shawangunk Mountains just south of the Rondout Siphon Tunnel, was holed through on Oct. 2, 1910.

THE HARMONIZING OF PATENT LAWS will be taken up by the International Congress for the Protection of Industrial Property which has been invited by the President of the United States to hold its next meeting at Washington, D. C., May 21, 1911. The date was originally set for May, 1910, but was postponed one year to give time for the 35 nations participating to prepare material to be considered. The congress will be composed of able and experienced delegates, most of them officials of the nations they represent. They will discuss and act upon measures to bring about international concessions and agreements in patent and trademark laws, with the object of harmonizing the laws of the various countries. At present the patent laws of different nations are so widely at variance as to cause great inconvenience to inventors and manufacturers.

LONDON ELECTRIC RAILWAYS.—Consul-General John L. Griffiths reports, in the Daily Consular Reports for Sept. 12, that the London County Council has decided to apply for power to construct 22.5 miles of electric tramways. In 1906 there were reported only 58.5 miles of electric tramway lines under the control of the Council while at present it controls 113.5 miles of electric lines and 19 miles of horse lines, carrying in all an average of 8,000,000 passengers weekly. In the year ending March 31, these tramways carried 451,000,000 passengers as against 314,000,000 in the preceding year. The London County Council has spent $52,071,550 in the purchase of old horse lines and converting for municipal electric operation. In the current year $8,759,700 is being spent in this work and, if the parliamentary powers sought are granted, a further sum of $4,886,500 will be expended. If the contemplated work is carried out, London will have approximately 150 miles of tramways carrying 15,000,000 passengers a week.

A LARGE BALL BEARING is described in "London Engineering" of Sept. 2, as designed for the center bearing of the Breydon Bridge of the Midland and Great Northern Rye. at Yarmouth, England. This bridge was opened in 1903, and the center bearing then used was formed by 69 2-in. balls, which were held between two rings having V-shaped grooves. In busy times this bridge turned about 400 times per month, and it was found recently that, owing to the V-grooves of the bearing not having been properly hardened, excessive wear had taken place. On consultation with specialists, another bearing was designed having 22 balls of 3½-in. diameter, which were arranged to run in segmental grooves. The radius of the grooves is 2¼ ins. When the bridge was originally built, great difficulty was found in getting the original bearings made, and no English firm could be found to undertake the construction of the second bearing just described. The bearing was made by a foreign firm and has recently been fitted in place by the railway employées. The designers preferred to use a cage for separating the balls, but they could not do so without reducing the number below what was considered safe. As the speed at which the bearing is worked is very low, this lack is not considered important.

ELECTRICAL INDUSTRY IN GERMANY.—German statistics relating to the imports and exports of electrical material show that 377 tons of electric lighting apparatus were imported into that country last year, and that 7,185 tons were exported, the imports being 3.3% above and the exports 11% below the figures for 1908. During 1909 69 tons of telegraph and telephone appliances were imported, and 1,601 tons were exported; in this case the imports were stationary, but the exports show an increase of 5.7% as compared with 1908. Measuring instruments formed the third largest item; of these 95 tons were imported and 1,223 tons exported, these figures being 19% and 15% above those for 1908.

The Board of Trade returns state that the imports of electrical machinery into the United Kingdom in 1908 amounted to 6,353 tons, and in 1909 to 5,461 tons, a reduction of over 16%, while our exports for those years were 18,482 tons and 18,698 tons, showing an increase of about 1.1%. The value of our imports of other electrical goods and apparatus increased from £1,263,702 ($6,120,000) in 1908 to £1,322,569 ($6,400,000) in 1909, while that of our exports rose from £1,943,104 ($9,400,000) to £2,230,799 ($10,750,000) in those years, equal to increases of 4.6% and 14.7%, respectively.—London "Times Engineering Supplement," Sept. 14.

A PECULIAR ACCIDENT to a 12-HP. direct-current motor is related in the London "Iron and Coal Trades Review" of Sept. 2. This motor was installed in the machine shop at a colliery and one morning on starting the machine became grounded and the fuses blew out. The trouble appeared to be between the ends of the armature coils and the core support at the commutator end. When the tails were disconnected and the commutator removed, four dead mice were found jammed against the core drum while the windings were charred and blackened with blood. It is supposed that the animals crawled into the armature through the end ventilating holes, for warmth, and were flung, on starting the motor, to the periphery of the cavity where centrifugal force squeezed the blood and liquids from their bodies. As a safeguard against such troubles in this plant the ventilating holes were covered with fine screening.

BUREAUS OF STATE RESEARCH, similar in general plan to the Bureau of Municipal Research established a few years ago in New York City and subsequently in a number of other cities, were suggested in a recent number of the Chicago "Evening Post." That daily remarks that:

The State of Illinois, for example, spends a biennial appropriation of $20,000,000. Recent investigations have shown that, aside from any question of corruption, wastefulness and extravagance have marked the expenditure of much of this money. Public-spirited citizens who have had their fill of spasmodic reforms in state politics might turn with great relief, it seems to us, to the organization of a Bureau of State Research, which should devote itself to the promotion of efficiency and economy of administration.

An important supplementary function which such a bureau could serve would be that of rendering to the smaller cities of the state the same expert service which the Bureaus of Municipal Research are giving to the larger cities. In 1908 there were thirty cities in Illinois ranging in population from 8,000 to 75,000 with a combined population of over 600,000 and a total annual expenditure of about $10,500,000.

The expense of maintaining in each of these cities a permanent bureau of expert accountants and engineers to make a study of local administrative conditions and to suggest improved business methods would, of course, be prohibited. But a centrally organized bureau which could send its experts from one city to another would be invaluable in promoting honest and efficient government in the smaller cities of the state.

In fact, the scheme is already being tried elsewhere with success. In Wisconsin, the extension department of the State University through its Municipal Reference Bureau is furnishing expert advice to cities of the state and is meeting with remarkable success. The function of the bureau here suggested would indeed be different, but the principle of organization would be much the same. In former times public-spirited citizens have not failed to respond to common-sense enterprises of this sort with liberal support. Such a bureau if wisely organized and administered would undoubtedly commend itself to the business judgment and the civic patriotism of a large number of our citizens.

A REPEATED-BENDING MACHINE giving a graphical record was also constructed by the above experimenters, and is described in the same paper. It employs a constant angle of bending in each case (46°), and measures the required moment by the deflection of a leaf spring which carries the jaws. On each reversal a strip of paper is shifted a short distance, and a pencil marking on it then is moved upward by a cord connected with the leaf spring, and so records its maximum deflection. The record then is a set of parallel lines of different lengths proportional to the moments active during bending. The results of tests on this machine can be compared with other tests only empirically.

ALKALI FROM PLASTER AS A DANGER TO CONCRETE.—The effect of water filtering through an alkali soil upon concrete has been shown in a number of instances in this country to be most deleterious to the structure of the concrete but we think that no engineer here has been alarmed by this action to the extent admitted by a French engineer of national reputation in a recent article in "Le Genie Civil." This engineer has had charge of the covering of one of the old Parisian canals

with a concrete arch filled over to the street level with earth. The contractor, in order to save money, procured most of his earth from nearby excavations, necessarily, on account of the age of the city, in places where old buildings had been torn down and where there was more or less ordinary house plaster in the material. This plaster contains a certain amount of sulphates as a basis of its composition and on this account the engineer-in-charge objected to the use of the excavated earth as a filling material, on the grounds that water filtering through the pile would put the sulphates into solution to the ultimate detriment of the concrete surface of the arch. Strict supervision was kept of all dirt wagons and those containing a marked amount of plaster were thrown out.

The arch surface was protected with two layers of tar and was in addition very well drained. So far as can be determined, ground water, only on occasions above the top of the arch, was the only water to be expected, with the possible exception of broken water or sewer pipes. In spite of this and also of the moderate amount of plaster that could be found in an ordinary house excavation, the engineer states that he noted several places where deterioration had started and attributes the decay to the alkali water resulting from the filtration through the plaster-containing earth.

WATER SIGN-POSTS IN DESERTS.—Dr. R. E. McDonald, a prominent mining man and prospector of Southern Nevada, is urging the necessity of the Government placing signs at intervals in Death Valley and at points on other Nevada deserts, pointing out water-holes, so that lives may be saved. In carrying on this campaign he shows scores of photographs of skeletons of men found on the desert, and shows how their lives could have been saved by such sign posts.

He states that he knows personally of seventeen men who have within the past year lost their lives in Death Valley, all for want of proper directions regarding water-holes.

The State authorities are in accord with the movement and are cooperating with McDonald in every possible way to secure this Federal action.

Death Valley has a greater record of deaths and unrecovered bodies from its terrible shifting sands than and other locality in this country. [Reno, Nev., dispatch in San Francisco "Chronicle," Sept. 19, 1910.]

AN OUTBREAK OF TYPHOID FEVER IN A COLlege community in Georgia, which affected four institutions simultaneously, was traced by means of chemical analysis to the pollution of a well. The pollution was found to be due to a break in the sewer at a point within 8 ft. of the wall of an old well. The water from this well was not used for drinking purposes but was held in reserve for fire protection. Located 150 ft. from the old fire-protection well was a second well, about 40 ft. deep, from which the drinking water of the institutions was obtained. After the typhoid outbreak, careful investigations were made of the institutional buildings, their food, milk and water-supplies. Everything appeared to be satisfactory, including the results of bacterial analyses of the water, except that the water from the well used for drinking purposes was high in nitrites, and particularly high in both chlorides and free ammonia, as compared with the normal water of the vicinity. From these chemical analyses as a starting point the water of the fire-protection well was subjected to analyses. Chemical examinations gave evidence of greater and more recent pollution than was shown by the analyses of the well used for drinking purposes. Bacterial analyses, made by the Johns Hopkins Bacteriological Laboratory, resulted in "strong presumptive evidence of the presence of bacilli coli." By the time the report on these analyses had been received, the sewers leading from the dormitory nearest to the fire-protection well had been uncovered. This disclosed "a broken joint and a hole in the side of the sewer an inch in diameter" within 8 ft. of the wall of the well. On introducing 3 lbs. of potassium iodide into the old well and making a test an hour later of the water in the well used for drinking purposes, iodine was detected in the latter. The break in the sewer was repaired and two weeks subsequently "chlorides in the well used for drinking water had fallen from 57 parts to 15 parts per million." Further evidence to the effect that the typhoid outbreak was due to the pollution of these wells is shown by the fact that the last reported case of typhoid occurred 20 days after the date when all the water from the well in question began to be subjected to boiling. The foregoing information has been taken from an article by H. B. Arbuckle in "The Journal of Industrial and Engineering Chemistry" for August, 1910.

TRAFFIC THROUGH THE SUEZ CANAL during 1909 recovered from the depression of 1908 (Eng. News, June 17, 1907, p. 675) and the progressive development which had been marked up to that time. The year showed the largest business of any since the canal was opened. During the year, 4,239 vessels, representing 15,307,527 tons, net, passed through the canal, an increase of 444 ships and 1,674,244 tons over 1908. The average tonnage of the ships passing through rose during the year from 3,592 tons to 3,635 tons, and the time of average passage was cut down 11 min. to 17 hrs. 13 min. In November, 1909, the largest vessel ever in the canal, the "Cleveland" of the Hamburg-American Line, passed safely through. Total receipts for the year were somewhat above 120,000,000 fr. as compared with 111,491,000 fr. in 1908.

THE MOTOR OMNIBUS is rapidly displacing the horse-drawn omnibus in London street traffic. It has been recently stated that in the last fiscal year, the London General Omnibus Co. made a profit of some $250,000 on its motor-omnibuses and a loss of over $200,000 on its horse-drawn vehicles. The operating expenses of the motor omnibus are said to average 5.2 cts. per mile and with maintenance, depreciation, sinking fund charges and interest on capital invested, the total cost is about 19.1 cts. per mile.

MILITARY DIRIGIBLE BALLOONS were tried in the German army maneuver on Sept. 8 with very disappointing results. The "Red" army sent its balloon, the "Parseval II." to reconnoiter the enemy's position, but the ship was caught in a rain storm which obliged it to descend within the enemy's lines and it was captured. The "M. 3," belonging to the "Blue" army, spent the day in reconnoitering the enemy's position at a height of 3,000 to 4,000 ft. in cloudy weather. The soldiers of the "Red" army had erected sham field works along the Oberlanden canals, using tree trunks for cannon. The crew of the "M 3" reported these sham field works as the main position of the "Red" forces, with the result that the main body of the "Blue" army halted all night before these sham fortifications to be in readiness to attack next morning, and lost advantages in the campaign which they had heretofore possessed.

Personals.

Mr. F. M. Mann, Professor of Architecture for the past eight years at Washington University, St. Louis, Mo., has been appointed Professor of Architecture in charge of that department at the University of Illinois.

Mr. J. F. Meister, Assoc. Am. Inst. E. E., recently of Kansas City, Mo., has been appointed an instructor in electrical engineering at the Oregon Agricultural College. He is a graduate of Cornell University class of 1905.

Mr. Morgan Brooks, M. Am. Inst. E. E., has returned to his work as Professor of Electrical Engineering at the University of Illinois after a year's leave of absence in the course of which he has made a trip around the world for recreation and study.

Mr. John A. Bensel, President of the American Society of Civil Engineers, has been nominated on the Democratic ticket for State Engineer and Surveyor of New York. Mr. Frank M. Williams has been nominated for reelection on the Republican ticket.

Mr. Wm. F. Zimmermann, M. Am. Soc. M. E., has re-associated himself with the Pittsburg Testing Laboratory, inspecting and consulting engineers, as Second Vice-President. He will have charge of the New York and New England office, which has been removed from 1 Liberty St. to 50 Church St., New York City.

Mr. John H. Gregory, M. Am. Soc. C. E., formerly in charge of the water purification and softening works and the sewage purification works at Columbus, Ohio, and later Resident Engineer on the Passaic Valley sewerage project at Newark, N. J., has been appointed Engineer on the Metropolitan Sewerage Commission of New York.

Mr. Thomas J. Morrison, M. Am. Soc. C. E., has resigned his position as Resident Engineer of the New York State Engineer's Department, at Rochester, N. Y., and has entered the field of general contracting in partnership with Mr. James F. Leary, of New York City, under the firm name of the Leary & Morrison Co. Mr. Morrison has been connected with the New York State Engineer's Department for 14 years.

Mr. George F. Swain, M. Am. Soc. C. E., Professor of Civil Engineering at Harvard University, has been appointed to take charge of the appraisal of the property of the New York, New Haven & Hartford R. R. in Massachusetts. The appraisal was authorized by the last State Legislature and was put into the hands of a special commission consisting of the railroad commissioners, tax commissioner and bank commissioner.

Obituary.

J. L. Fisher, Acting City Architect of San Francisco, Cal., was killed in an automobile wreck in that city Sept. 28.

Nicholas Monsarrat, President of the Ka[illegible] & Michigan Ry., and formerly President of the [illegible]king Valley Ry., died Sept. 30 at the Murray Hill [illegible]rium in New York City. He was born at London, [illegible] in 1839. In 1877 he became General Manager of [illegible] Paducah & Memphis R. R. and in 1881 he serve[illegible] six months as General Superintendent of the Ch[illegible]ake, Ohio & Southwestern Ry. He has served [illegible] December, 1881 as General Superintendent, Gene[illegible] Manager, President and Receiver of a number of ra[illegible]ys in Ohio. Mr. Monsarrat's death terminated a [illegible]d of several months of ill health following a serio[illegible]injury received in a taxicab accident.

Engineering Societies.

COMING MEETINGS.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.
Oct. 10-14. Annual convention at Atlantic City, N. J. Secy. H. C. Donecker, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 11-14. Annual convention at Erie, Pa. Secy., A. P. Folwell, 239 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 11-13. Annual meeting at Richmond, Va. Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN ELECTROCHEMICAL SOCIETY.
Oct. 13-15. Annual meeting at Chicago, Ill. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 18-20. Annual convention at Denver, Colo. Secy., C. A. Lichty, Chicago & Northwestern Ry., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 19-21. Annual meeting at New York City. Secy., A. B. Beadle, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 21-Nov. 15. Canal Zone meeting. Secy., R. W. Raymond, 29 West 39th St., New York City.

ILLUMINATING ENGINEERING SOCIETY.
Oct. 24. Annual convention at Baltimore, Md. Secy., P. S. Miller, 29 West 39th St., New York City.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 15. Annual meeting at Washington, D. C. Secy., Wm. H. Connelly, Interstate Commerce Commission, Washington, D. C.

AMERICAN RAILWAY ASSOCIATION.
Nov. 16. Semi-annual meeting at St. Louis, Mo. Secy., W. F. Allen, 24 Park Pl., New York City.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 17-18. Annual meeting at New York City. Secy., W. J. Baxter, 29 eWst 39th St., New York City.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Nov. 17-19. Annual convention at Boston, Mass. Secy., James C. Monaghan, 20 West 44th St., New York City.

NEW JERSEY SANITARY ASSOCIATION.
Dec. 2-3. Annual meeting at Lakewood, N. J. Secy., J. A. Exton, 75 Beech St., Arlington, N. J.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 5-6. Annual meeting at New York City. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 6-9. Annual meeting at New York City. Secy., C. W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 7-9. Annual meeting at New York City. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 12-14. Annual convention at New York City. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Pa.

NATIONAL ASSOCIATION OF CEMENT USERS.
Dec. 12-23. Annual convention at New York City. President, Richard L. Humphrey, Harrison Bldg., Philadelphia.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—The third annual convention will be held at Chattanooga, Tenn., May 15-18, 1911. The secretary is Mr. D. B. Sebastian, 703 La Salle Station, Chicago, Ill.

NATIONAL IRRIGATION CONGRESS.—At the recent meeting held at Pueblo, Colo., officers were elected as follows: President, B. A. Fowler, of Arizona; Secretary, Arthur Hooker, Spokane, Wash. The next meeting will be held at Chicago in 1911.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—At the regular monthly meeting to be held in the Engineering Societies' Building, New York City, Oct. 11, Mr. Frank B. Gilbreth, of New York City, will present a paper entitled "Fires: Effects on Building Materials and Permanent Elimination." This paper, in which Mr. Gilbreth upholds concrete as the best fireproof building material, will be illustrated by lantern slides showing the effect of a destructive fire on a typical steel-frame building. Mr. H. de B. Parsons will show by means of lantern slides the effect of fire on a number of office buildings. Among those expected to discuss the subject of fireproofing at this meeting are Henry M. Keasley, of the National Fire Proofing Co.; Ira H. Woolson, of the National Board of Fire Underwriters; Wm. D. Grier, of the National Fire Protection Association; and C. A. P. Turner, of Minneapolis, Minn.